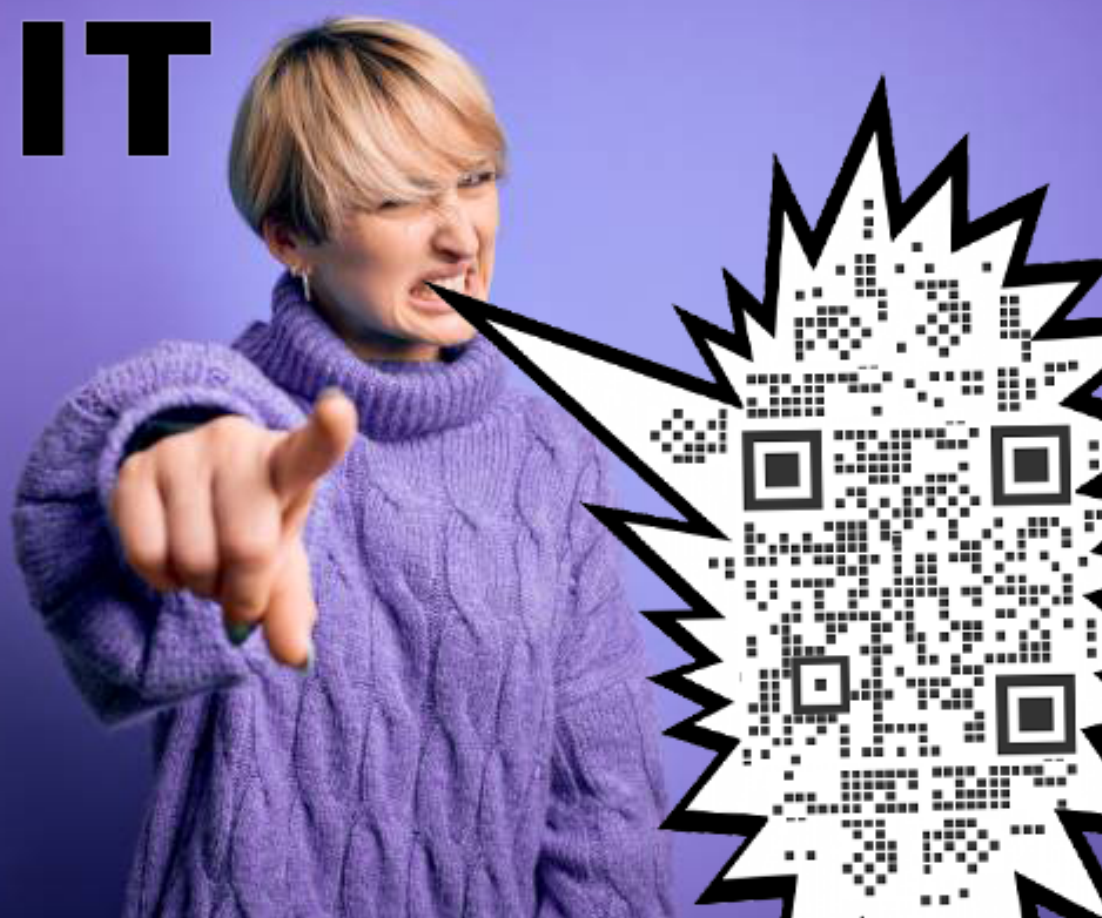


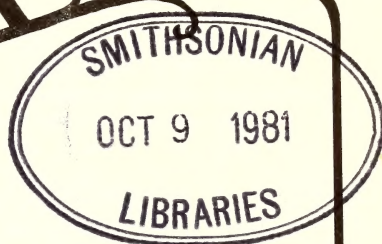
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Hawaiian Botanical Society



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VOLUME 18 NUMBER 1/2

FEBRUARY/APRIL 1979

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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

ANNUAL REPORT OF THE TREASURER
December 1, 1977 - November 30, 1978

RECEIPTS:

Dues	\$305.50	
Gifts	525.00	
Index Sales	2.00	
Interest	848.10	
	-----	\$1,680.60

EXPENDITURES:

Postage	190.83	
Newsletter	849.16	
Gifts (Wau Institute)	100.00	
Native Plant Project	558.25	
Index, Newsletter	649.80	
	-----	2,348.04

NET WORTH OF THE SOCIETY:

Nov. 30, 1977	14,049.88
Nov. 30, 1978	13,382.44
Change	(667.44)

BALANCES IN BANKS:

First Hawaiian Bank Commercial Account	
Balance 11/30/77	274.96
Deposits	
12/1/77 - 11/30/78	2,832.50
Withdrawals	
12/1/77 - 11/30/78	(2,348.04)
Balance 11/30/78	759.42

First Federal S. & L., Marie C. Neal Account	
Balance 11/30/77	\$13,626.10
Interest earned	
12/1/77 - 11/30/78	827.94
Transferred to checking account	
	(2,000.00)
Balance 11/30/78	\$12,434.04*

*Includes \$10,000.00 in 6 yr. certificate at 7.75% interest.

First Federal S. & L., Marie C. Neal Account	
Balance 11/30/77	148.82
Interest earned	
12/1/77 - 11/30/78	20.16
Balance 11/30/78	\$168.98

Respectfully submitted
C. H. Lamoureux, Treasurer

UNIFORM CULTURE AND PROPAGATION OF HAWAIIAN TARWEEDS

Gerald D. Carr
Department of Botany
University of Hawaii at Manoa
Honolulu, Hawaii 96822

In conjunction with ongoing studies of adaptive radiation in the Hawaiian silversword alliance, several Hawaiian endemics have been established in a growth chamber in the Department of Botany at the University of Hawaii (Table 1). Propagation has been accomplished by rooted cuttings in some cases and by seeds (fruits) in others (Table 1).

Rooting has been promoted by the application of Rootone-F (Amchem Products, Inc.) prior to placing the cuttings in horticultural sponge rock under intermittent water mist in a greenhouse. The rate of success and the time required for rooting depended upon the species involved. Dubautia scabra (DC.) Keck cuttings rooted quickly, while cuttings of D. latifolia (Gray) Keck required repeated attempts and a period of many weeks before roots appeared. Other species fall somewhere between these extremes in difficulty of rooting cuttings.

Seeds (fruits) for propagation were soaked in water, screened for the presence of embryos (a tedious process!), and placed on water-soaked filter paper in petri plates to which a pinch of Bordeaux mix was added to retard the growth of fungi. In most instances removal of the fruit wall greatly reduced the time required for germination. Removal of the nucellar envelope also usually enhanced germination. While most undamaged fresh embryos will germinate within a few days, many plants produce an extremely low frequency of fruits with embryos. Thus, propagation by this method can be rather time consuming if large numbers of individuals are desired.

Rooted cuttings and seedlings were potted in a mixture containing two parts "supersoil" (Rod McLellan Co.) and one part horticultural sponge rock, then placed in a growth chamber set for a 15-hour photoperiod. The temperature minimum is about 10°C and the maximum is about 25°C. Several plants have flowered in the growth chamber (Table 1). An individual of Dubautia platyphylla (Gray) Keck grown from seed achieved a height of 1.2 m in less than 18 months.

The synchronous flowering of several pairs of species has allowed the production of many interspecific and infraspecific hybrids (Table 2). These hybrids are being maintained in cultivation so that they can be analyzed meiotically to determine chromosomal relationships of the parents in the manner already accomplished for several naturally occurring hybrids (Carr and Kyhos 1981). The cultivated species and hybrids also are being used in electrophoretic and chromatographic studies of the Hawaiian silversword alliance.

LITERATURE CITED

Carr, G. D. and D. W. Kyhos. 1981. Adaptive radiation in the Hawaiian silversword alliance (Compositae-Madiinae). I. Cytogenetics of spontaneous hybrids. *Evolution* 35(2): in press.

TABLE 1. Species of the silversword alliance in cultivation.

TAXON	METHOD OF PROPAGATION	SOURCE
<u>Argyroxiphium grayanum</u>	Cuttings	Maui
<u>A. macrocephalum</u>	Seeds	Maui
<u>Dubautia arborea</u>	Seeds	Hawai'i
<u>*D. ciliolata</u>	Seeds	Hawai'i
<u>*D. herbstobatae</u>	Cuttings	O'ahu
<u>*D. knudsenii</u>	Seeds, cuttings	Kaua'i
<u>D. laevigata</u>	Cuttings	Kaua'i
<u>D. latifolia</u>	Cuttings	Kaua'i
<u>*D. linearis</u> var. <u>linearis</u>	Seeds, cuttings	Maui
<u>*D. linearis</u> var. <u>opposita</u>	Seeds, cuttings	Moloka'i
<u>*D. laxa</u> (2 var.)	Seeds, cuttings	O'ahu
<u>D. menziesii</u>	Seeds, cuttings	Maui
<u>*D. microcephala</u>	Seeds, cuttings	Kaua'i
<u>*D. montana</u>	Cuttings	Hawai'i
<u>*D. paleata</u>	Cuttings	Kaua'i
<u>D. plantaginea</u>	Cuttings	Moloka'i, O'ahu
<u>D. platyphylla</u>	Seeds, cuttings	Maui
<u>D. raillardiodides</u>	Seeds, cuttings	Kaua'i
<u>*D. scabra</u> var. <u>scabra</u>	Seeds, cuttings	Hawai'i
<u>*D. scabra</u> var. <u>munroi</u>	Cuttings	Maui
<u>*D. scabra</u> var. <u>leiophylla</u>	Seeds, cuttings	Maui, Moloka'i and Lana'i

TABLE 1 (continued)

<u>*D. sherffiana</u> (2 var.)	Seeds, cuttings	O'ahu
<u>D. waianapanapaensis</u>	Cuttings	Maui
<u>Wilkesia gymnoxiphium</u>	Seeds, cuttings	Kaua'i
<u>W. hobdyi</u>	Cuttings	Kaua'i

* Flowered in growth chamber.

TABLE 2. Synthetic hybrids of the silversword alliance in cultivation.*

**Dubautia knudsenii Hbd. n=14 (K) X D. ciliolata (DC.) Keck n=13 (H)

D. knudsenii n=14 (K) X D. laxa H. & A. n=14 (O)

D. knudsenii n=14 (K) X D. linearis (Gaud.) Keck var. opposita (Sherff)
Keck n=13 (Mo)

D. knudsenii n=14 (K) x Wilkesia gymnoxiphium Gray n=14 (K)

D. knudsenii n=14 (K) X D. scabra (DC.) Keck n=14 (M)

D. laxa n=14 (O) X D. scabra n=14 (M)

D. laxa n=14 (O) X D. sherffiana Fosb. n=13 (O)

D. linearis var. linearis n=13 (M) X D. linearis var. opposita n=13 (Mo)

D. menziesii (Gray) Keck n=13 (M) X D. ciliolata n=13 (H)

D. microcephala Skottsb. n=14 (K) X D. linearis var. linearis n=13 (M)

D. microcephala n=14 (K) X D. scabra n=14 (H)

D. microcephala n=14 (K) X D. sherffiana n=13 (O)

D. scabra n=14 (M) X D. linearis var. linearis n=13 (M)

**D. scabra n=14 (M) X D. linearis var. opposita n=13 (Mo)

D. scabra n=14 (M) X D. sherffiana n=13 (O)

D. sherffiana n=13 (O) X D. linearis var. opposita n=13 (Mo)

* Letters in parentheses after each taxon indicate the island source of parental material: K = Kaua'i, O = O'ahu, Mo = Moloka'i, M = Maui, H = Hawai'i.

**Flowered in growth chamber.

SOME RECOLLECTIONS
OF
THE LATE THEODOR PHILIP HAAS

O., & I. E. M. Degener
S. J., & S. Taussig

We residents of O'ahu have had an outstanding botanist living in our midst for over a decade without fully appreciating him, nor profiting from his knowledge and wisdom. He visited the homes of the four of us on the North Shore of O'ahu and at Waikiki, and we, in turn, visited him at his apartment on Kuhio Ave. and later at his quarters at the Laniolu Good Samaritan Center on Lewers St. Whenever we could wean him from the radio or television (he had a passion for classical music), we enjoyed conversing with him on biological matters. He regularly attended meetings of the Hawaiian Botanical Society as well as seminars at the Department of Botany, University of Hawaii at Manoa until illness made it too difficult for him to continue. He was invariably charming, courteous and enthusiastic with us, though to non-botanical acquaintances he often appeared antisocial. This latter attitude we ascribe to his persecution in Germany during the time of Hitler. In his later years, he also suffered considerable distress from acute rheumatoid arthritis. This illness made him increasingly dependent on a wheel chair.

He was always surrounded by a fascinating clutter of books, pamphlets, old letters, photographs and other memorabilia. He studied plant morphology under Karl Goebel in 1911-12--his bound notebook, still extant, is of considerable interest in showing how the student reacted to the man and the course. He studied the genus Acer under Fritz von Wettstein, earning his Doctorate at Munich on December 21, 1932. Between 1929 and 1937, Dr. Haas set up exhibits, preparing pharmaceutical and other specimens for the Botanical Museum and for lectures at the University of Munich. One of his major projects was rearranging the entire exhibition according to modern museum principles.

Dr. Haas fled Germany by way of Siberia and arrived in San Francisco on September 21, 1940. He became an American citizen on June 17, 1941. He did consulting work at the New York Botanical Garden in the Bronx, and the American Museum of Natural History in Manhattan. He later moved to Philadelphia where he was a volunteer in the herbarium of the Museum of Natural History. Until his retirement due to ill health, he was a professor at the Philadelphia College of Pharmacy and Science.

While working at the New York Botanical Garden he noted the name 'Degener' on many Hawaiian specimens. Though total strangers, we began a correspondence on the prevalent conditions in the islands. Pleased with what he had heard, he relocated to Honolulu, in 1964, to bask in the sunshine of our salubrious climate.

He gave a notable paper on the date palm at the AAAS Convention in Philadelphia but did not publish much in the formal literature. On the other hand, his letters are replete with original observations about

plants from a mainly morphological point of view. An outstanding scientist, Dr. Haas was greatly interested in music. As illness reduced his physical ability, he became more and more dependent on his radio and television. He would frequently advise friends and acquaintances on stations and programs. His delightfully human side was shown in his wish to be buried with his prized radio.

Due to Dr. Haas' close association with Philadelphia institutions, the Executors of his Estate sent his literary possessions to Pittsburg for preservation. In fact, we learned much of Dr. Haas' early history from the Hunt Institute of Botanical Documentation.

SECRETARY'S ANNUAL REPORT - 1978

Three field trips were held by the society in 1978. In March, a field trip to Ka'ena Point was led by Drs. Carr and Herbst. In April, Dr. Paul Weissich, director of Honolulu Botanic Gardens, led a tour through Koko Crater Botanic Garden. Mr. Keith Woolliams, horticulturist at Waimea Arboretum, conducted a tour of the arboretum grounds.

Speakers for the society's monthly meetings were as follows:

December	Dr. Isabella A. Abbott on "The Influence of major food plants on the social system of old Hawaii."
January	Dr. Paul R. Weissich on "A collecting trip to Latin America."
February	Mr. Ted Green on "Collecting in Melanesia."
March	Dr. Douglas Yen of the Bishop Museum on "Cave Dwellers of the Philippines."
April	Dr. Raymond Fosberg of the Smithsonian Institute on "Floristic Research in Polynesia and Micronesia."
May	Dr. Harold St. John on "History of Hawaiian Botany."
June	Dr. Frank Tabrah on "Polynesian Medicine."

The Society adjourned for the summer and the next meeting was held in October.

October	A team of speakers consisting Dr. Charles Lamoureux, Ms. Lani Stemmermann, Mr. Paul Higashino and Mr. Rick Warshauer on "The Botany of Pohakuloa."
November	Mr. John Obata gave his Presidential Address on "Native Hawaiian flora - a projection on collecting, propagation, and preservation."

In addition a short talk on the "Plant of the month" was given at each meeting.

The year saw a number of the society's Newsletter published, however, article contributions were always and still are in short supply.

Financially, the society is just keeping ahead of inflation. Membership dues may be raised in the future.

Winona P. Char, Secretary

MINUTES OF THE REGULAR MEETING OF NOVEMBER 6, 1978

The meeting was called to order by the President, Mr. J. Obata, at 7:35 p.m.

The nominating committee presented the following proposal for the Society officers for 1979.

President	- Mr. Keith Woolliams
Vice-President	- Mr. Nadarajah Balakrishnan
Secretary	- Ms. Winona Char
Treasurer	- Mr. Lowell Funk
Directors	- Dr. Gerald Carr
	Mr. John Obata (retiring President)

A motion was made to accept the nomination. The motion was seconded and carried without objection. The President-Elect is a graduate of Kew Gardens. He is currently the Director of the Waimea Botanical Garden. He is particularly interested in the propagation of endangered Hawaiian plants. Mr. Balakrishnan is a candidate for the Ph. D. degree in Botany at the University of Hawaii. He is a plant ecologist and is currently working on the 'Ohi'a decline problem. Ms. Char is a candidate for the M. S. degree in Botany at the University of Hawaii. She is revising the taxonomy of the Hawaiian species of the genus Sesbania. She has extensive field experience, particularly on the island of O'ahu, and has been very active in preparing environmental impact statements. Mr. Funk is a local businessman with a general interest in Hawaiian botany and conservation. Dr. Carr is an assistant professor in Botany at the University of Hawaii. He is a biosystematist and is working on the Hawaiian tarweed complex. Mr. Obata, our retiring President, is a local schoolteacher who has a broad interest in the conservation and cultivation of Hawaiian plants. He is a very active fieldworker and is one of the best sources of information on plant localities on O'ahu.

President Obata expressed special thanks to all who contributed to the plant exchange, especially to Messrs. Ray Baker, Oscar Kirsch, and Ted Green for their generous donations.

The Audubon Society invited members to their November 20th meeting at the Waikiki Aquarium.

Mr. Steve Montgomery announced that the State Fish and Game have removed the watering trough that was located near the dryland forest at Kanepu'u on Lana'i. The trough attracted deer in the area which had a negative impact on one of the last remaining dry forests on the island. President Obata announced that the society may have to increase dues by \$1.00; any helpful suggestions on raising funds for the society are welcome.

John Obata presented the plant of the month, Stenogyne kanehoana. This particular species is on the proposed list of Rare and Endangered Plants by the Federal government. It is unusual because unlike most Stenogyne, this species has large flowers about 2 inches long.

President Obata then gave his Presidential Address; "Native Hawaiian Flora - A projection on collecting, propagating and preservation".

Winona P. Char, Secretary

FIRE, LIGHTNING, AND 'OHI'A DIEBACK

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INTRODUCTION

'Ohi'a dieback (or decline) is a phenomenon of concern to all those interested in native Hawaiian ecosystems. It is characterized by stands of dead and dying 'Ohi'a (Metrosideros collina var. polymorpha) tree areas that were formerly healthy forest. Although stands of native forest in a dieback condition have been reported on Kaua'i, O'ahu, Maui, and in Hawai'i, most of the investigations into the problem have been centered on the island of Hawai'i. Within this area Mueller-Dombois et al. (1977) defined five types of 'Ohi'a dieback, the two major types being designated as Wetland and Dryland dieback.

Although several theories have been advanced concerning the nature of 'Ohi'a dieback, there are only two theories that have been areas of active research (Mueller-Dombois et al. 1977) The dynamic phasing theory for the Wetland and Dryland dieback (Mueller-Dombois et al. 1977) states that the canopy collapse is a mechanism which allows the shade intolerant 'Ohi'a to maintain its dominance in the Hawaiian rain forest. In this theory the trigger for Wetland dieback is soil drought coupled with an increasing demand on limited soil resources as the community matures. The complex ecological interactions needed to substantiate this theory are poorly understood at present though a massive research effort to collect the necessary data is underway. The other recently researched theory for the cause of 'Ohi'a decline is the disease theory (Petteys et al. 1975). In simplest terms, this theory stated that the fungous root pathogen Phytophthora cinnamomi and the 'Ohi'a wood borer, Plagithmysus bilineatus, working separately or together, were the causative agents of 'Ohi'a decline. However, Papp et al. (1979) reported that neither of these organisms can be considered a primary cause of the decline, but rather that their presence at dieback sites is an effect of the occurrence of dieback.

This paper presents two new hypotheses concerning possible triggers for 'Ohi'a dieback. Basically, these hypotheses concern the role of fire and lightning in producing symptoms in rain forests that could be described as dieback. The hypothesis concerning fire states that the 'Ohi'a dieback we are witnessing now on the windward slopes of the island of Hawai'i is an ecosystem function to replace the nutrients lost in a severe fire which occurred in the area within the last 100 years, and that dieback will keep recurring until a nutrient budget of pre-fire levels is restored. This fire hypothesis pertains particularly to Wetland dieback (including cluding the subtype Bog-formation dieback). The hypothesis concerning lightning states that areas of 'Ohi'a forest up to 1.5 acres in area are killed by individual lightning strikes, and that one of the side effects of the lightning strike could be the attraction of the 'Ohi'a wood borer to the site. This lightning hypothesis pertains particularly to Dryland dieback. The two proposed triggers work on different time scales, with the effect of fire manifesting itself 50-100 years after the fire event, and the effect of lightning manifesting itself immediately. In natural ecosystems

lightning and fire are often connected in a cause and effect relationship, but for the purposes of this paper they are treated

as independent events. That is, the possible effects of fire on Hawaiian rain forest ecosystems, regardless of the cause, will be examined, and the possible effects of lightning on these ecosystems, ignoring its role as an ignition source, will be examined.

FIRE IN HAWAIIAN RAIN FOREST ECOSYSTEMS

There is disagreement in the literature on the role of fire in the Hawaiian rain forest. Indeed, it is almost a disagreement on the possibility of fire in the rain forest.

Vogl (1969) devotes 55 pages "to demonstrate that Hawaiian vegetation, in general, is far from pristine; that throughout its existence it has been continuously besieged by catastrophies, including fire; .. and (that) much of the flora has been affected by, or adapted to, fire as well as other disturbance factors." He concludes that "fire is considered to have played a continued role in the evolution of a substantial part of the Hawaiian flora and vegetation, along with other widespread disturbances." and that "fires are considered to have been part of the Polynesian and pre-Polynesian environment, being so infrequent in some regions as to leave only the most subtle effects, and so frequent in others as to shape a plant cover resembling fire types anywhere."

Concerning fire occurrence in the rain forest, Vogl (1969) states that "just as the wetter parts of the islands are subject to occasional droughts, they are also subject to periodic fires. On Hawaii, for example, fires occurred repeatedly over the wettest areas. In fact, fires may be more common in windward than in leeward regions of the island of Hawaii, because large leeward areas are occupied by barren lava flows or semi-desert incapable of carrying fire. The windward slopes average 150-300 inches of annual precipitation and were last frequented by droughts in 1967 and 1965, which were attended by sizeable fires."

As far as 'Ohi'a forests are concerned, Vogl (1969) states that "the coppiced growth, monotypic nature, uniform size, and even aged character of many Metrosideros stands reflect catastrophic or disturbance origins such as fire." He later qualifies this somewhat, stating that "Metrosideros and Metrosideros-Cibotium forests may not be dependent on fire, and not all Metrosideros stands are related directly to fires. But these forests do burn, and these opportunistic species take advantage of the pioneer conditions created."

Mueller-Dombois (1978) in a review paper on fire in the tropics states that "natural fires have played no significant role in the development of tropical rain forests; that is, fire has not been important as an evolutionary stress factor." In their report on 'Ohi'a dieback, Mueller-Dombois et al. (1977) state "neither fire, nor hurricanes are important perturbations in the Hawaiian montane rain forests."

Mueller-Dombois' arguments seem to be that because of the infrequent nature of fire in the Hawaiian rain forests, its effects in shaping the characteristics of the vegetation have been minimal. In Mueller-Dombois (1978) he states:

Vogl pointed out that since the Pacific N.W. rain forest can burn, it should also be possible for the Hawaiian rain forest to burn. However, there is an annual dry season in the Pacific N.W. in July and August, and no such annual dry season is apparent in the Hawaiian rain forest environment. If anything, this speaks for a lower fire frequency in Hawaii. Year-to-year variations in rainfall do occur and Vogl pointed out that they can produce drought in the rain forest. He describes a situation in the east Maui rain forest above Hana in 1969 when mossy epiphytes, lichens, ferns and the bark of 'Ohi'a trees had become so dry that upon igniting with a match, "fern, duff, green fern fronds, and surface forest litter produced a roaring fire (Vogl, 1969:21). However, broad area burning has never been witnessed in the closed Hawaiian rain forests, only in seral or degraded stages.

He then reports on data provided by Lipman et al. (1978, in Mueller-Dombois 1978) concerning the discovery of charcoal in a soil pit dug in the Ola'a tract. "The samples were carbon dated and gave as ages 340-200, 1040-200 and 2080-200 years. This shows that repeated fires have definitely occurred in certain sections of the Hawaiian rain forest. However, the fire frequency of 700- to 1000-year intervals is low. It correlates with vulcanism and not with drought years in these cases."

In fact, then, there is not much disagreement as to the possibility of fire in the Hawaiian rain forest, but rather, a disagreement as to its frequency, origin, and effects in shaping the characteristics of the vegetation. That disagreement will not be dealt with here. Vogl (1969) analyzed the fires on record (since about 1900) which were mostly caused by man and as such have been quite frequent. Mueller-Dombois (1978) states "With the occupation of the Hawaiian Islands by people and the advent and penetration of exotic grasses in many Islands by Hawaiian ecosystems, fire has recently become more important, but as a newly disturbing rather than natural stress factor." However, the point here, with which both Vogl and Mueller-Dombois seem to agree, is that it is possible for the rain forest to burn and that it has done so in the past.

It is my belief that the situation in the Hawaiian rain forest is similar to the situation described by Christensen (1978) concerning the cedar swamp forests of the S.E. United States. He states that "although fire may play a significant role in the development of such ecosystems we would hardly view it as a homeostatic mechanism. Fire occurrence in these ecosystems is related to the chance co-occurrence of an ignition source and suitable climatic conditions, rather than internal trends in the vegetation which increase fire probability. Fire in these ecosystems may indeed be analagous to an injury from which the ecosystem must recover."

Given that fires do and have in the past occurred in the Hawaiian 'Ohi'a rain forests, what is the nature of these fires? First of all they are very infrequent, the most reliable estimate being at 700 to 1000 year intervals under natural conditions (Lipman et al. in Mueller-Dombois 1978). They most probably occurred during the chance co-occurrence of a drought and ignition either by "dry" lightning or by spread from a lava flow. In any case, after 700 years surely a dense forest would be present, and it would be expected to produce a very intense fire. Indeed the "roaring fire" produced by Vogl using a single match is evidence of this.

Furthermore, there is other evidence of intense fire in the rain forests of Hawai'i, almost always occurring during droughts. A 3250 acre fire on the island of Hawai'i in November 1954 occurred "after months of the most prolonged and continuous drought which has been experienced in the memory of living persons" (Hawaii Forest Records, in Vogl 1969). On June 6, 1921, 15 acres of forest on Hawai'i burned as the "fire spread by sparks being blown into the dry moss on the trees" (Judd 1921a, in Vogl 1969). Hall (1904) described a 1902 fire which burned an area 15 miles long and 2 to 4 miles wide in southern Hamakua, Hawai'i. The fire was preceded by several months of severe drought, and burned with rapidity through dense forest of 'Ohi'a-lehua and koa with a heavy understory of tree ferns and other ferns. (Hall also describes another area that he believed had burned about 50 years before in the same area, but his supporting evidence that this was indeed a fire area is not substantial).

Thus, there is evidence of intense fires burning through closed rain forest areas on the Big Island, and furthermore, the one described by Hall (1904) seems to have occurred in the general vicinity (southern Hamakua) where 'Ohi'a dieback is now occurring.

EFFECTS OF INTENSE FIRES ON ECOSYSTEMS

Christensen (1978) states that "fire is usually considered to have the most devastating effects in those ecosystems where it is infrequent and intense." But what is the nature of these "devastating effects" on ecosystems?

A review paper by Woodmansee and Wallach (1978) on the effects of fire on biogeochemical cycles provides some answers. The following series of statements are taken directly from that source:

- Fire can influence biogeochemical cycling in ecological communities in widely varying ways ranging from stimulation of growth ...in some grasslands to total destruction of not only vegetation but entire soil-plant-animal-microorganism systems in some formerly forested landscapes.

- Intense fires that kill large proportions of whole plants or all vegetation drastically alter cycling patterns.

- Ecosystems that contain large amounts of nutrients above ground in aerial portions of plants (e.g. forests, some shrublands) or in rich organic layers (e.g. forests, some tundra communities) are quite vulnerable to catastrophic losses of nutrients. Not only are nutrients more exposed to combustion but because of the large amounts of organic matter above ground, the probability of high intensity, totally consuming fires is much greater. Large amounts of N as gas and other elements may be lost from such high intensity fires. Replacement of nutrients lost during combustion may take decades to replace by atmospheric deposition inputs alone.

- In systems where high intensity fires occur, and especially where root systems are killed, large secondary losses of nutrients may occur if precipitation or wind events are extreme.

-Nutrients contained in ash must be solubilized in order to become available for uptake by roots or microorganisms. In solution ions not only become available for uptake but they are also vulnerable to loss in surface runoff, they may be leached into the soil profile where they may be retained on exchange sites of soil colloids, they may be leached through the soil profile and out of the root zone (especially if the roots have been killed).

-Deep soils high in clays or colloidal organic matter but not saturated with Aluminum probably can retain the majority of ions passed into them from the surface ash. Shallow soils that are low in organic matter content would retain few ions with the remainder vulnerable to loss from the community if sufficient water is present to carry them out.

-We emphasize the point that in ecosystems that are infrequently burned and in which biomass accumulates to such a degree that holocaust is catastrophic, the patterns of nutrient cycling can be greatly altered. This is especially true if severe soil erosion occurs and the integrity of the soil-microorganism-animal-plant root system is disrupted.

-If the vegetational cover was substantially destroyed by the fire, "pioneer" species of plants that germinate and grow rapidly take in large quantities of nutrients. Following (this), more permanent vegetation-microorganism-animal systems develop that can efficiently utilize the nutrients mineralized from excessive populations of microorganisms and pioneer plants.

This sequence of events following fire are consistent with hypotheses of nutrient retention by ecosystems presented by Vitousek and Reiners (1975) and Woodmansee (1978) who suggest that nutrient retention by early seral communities may be very efficient.

-We hypothesize that one ecosystem "adaptation" of successional vegetation is to maintain gene pools from which plants can become quickly established and "immobilize" nutrients.

-We believe the fact that many pioneer species have the propensity to accumulate large concentrations of nutrients, especially N, is more than just coincidental.

-We do infer, however, that in communities that have been burned and particularly those that have been severely depleted of nitrogen by fire, that nitrogen fixation can be a very important replenishing mechanism without which community recovery may take decades or centuries.

Mueller-Dombois (1978) contributes the following along these lines:

-Brinkmann and deNascimento report on the effects of tree felling with subsequent burning in the Amazon forest on latosols near Manaus and say that although large amounts of nutrients are rapidly released to the soil after burning, much is lost by leaching or becomes fixed and therefore is lost from the site potential.

-A few observations on forest succession following fire are available in tropical rain and seasonal forest areas. When the area is not too large and not converted for too long, natural forest appears possible in tropical forest areas. However, in larger-sized forest conversions, there is rapid site degradation in tropical rain forest areas in terms of erosion, loss of nutrient potential and deterioration of soil-physical properties (particularly ironstone formation). Site deterioration processes are also indicated for seasonal forests, but on a less rapid time scale.

These facts, observations and hypotheses are particularly pertinent when we remember that 'Ohi'a is a pioneer species, as well as a "climax" species. Also, it is not a leguminous plant and is unable to fix atmospheric nitrogen. Furthermore, these effects of intense fires on ecosystems coupled with the past occurrence of intense fires in the 'Ohi'a rain forest ecosystems, seem to be related to certain observations concerning 'Ohi'a dieback.

Perhaps the real question here is--if we accept that there was an intense fire over a large area in southern Hamakua, as reported in Hall (1904), and that such an intense fire is "analagous to an injury from which the ecosystem must recover" (Christensen 1978) and resulting in a high degree of alteration of nutrient cycling systems (Woodmansee and Wallach 1978), where is there an area that could be described as a fire "scar"?

THE RELATION OF FIRE TO 'OHI'A DIEBACK; A HYPOTHESIS

There are four facts of 'Ohi'a dieback that perhaps can be explained by the occurrence of an intense fire in the past in the dieback area. Specifically, these facts apply to the areas termed Wetland Dieback and Bog-formation Dieback, and somewhat to Dryland Dieback (Mueller-Dombois et al. 1977).

1). Kliejunas and Ko (1974, in Mueller-Dombois et al. 1977) showed that the deficiency of inorganic nutrients is a factor in 'Ohi'a decline, that is, they showed that 'Ohi'a trees "come back" after fertilization, which implies that the dieback is really a premature death of 'Ohi'a trees due to a severe nutrient shortage in the soil.

What is the original cause of this nutrient shortage? If the nutrient deficiency is a result of the natural processes involved in the weathering of the basaltic parent material, it would seem logical to expect a correlation between dieback occurrence and the age of the underlying lava flow; that is, the dieback should be occurring mostly on similarly aged substrates within any one area. Although it was not looked into in depth (i.e. no comparison of a lava flow map and the map of the dieback area was made), the spatial distribution of the dieback argues against such a correlation in that Wetland Dieback and Bog-formation Dieback are aligned in a generally North-South orientation (Mueller-Dombois et al. 1977), which is nearly perpendicular to the general direction of lava flows in the Hamakua area.

However, the review paper by Woodmansee and Wallach (1978) quoted extensively in the previous section, indicates that an infrequent, severe

fire in an area of heavy rainfall (and thus much runoff and leaching) and in an area with shallow soils that are possibly saturated with Aluminum, would deplete that area of a very substantial portion of its nutrients. In contrast to the depletion of nutrients by weathering, a fire-caused nutrient deficiency would not be expected to correlate with the age of the substrate. Furthermore, there is evidence in the literature (Hall 1904, Vogl 1969) of severe fires in the area that is now exhibiting dieback, although the directional orientation of these fires is not reported.

2). The presence of a hardpan is reported in certain dieback areas. Mueller-Dombois et al. (1977) report that "one of our releves (in the Bog-formation dieback area) showed a hardpan at about 30-50 cm depth in the soil profile (at several places in the releve), which resembled a weakly cemented clay layer. The layer was easily cut by a knife. But the soil above was water-soaked, and it was drier below the hardpan." They go on to quote Fosberg who "concluded many years ago from his observations of 'Ohia dieback in montane wetland forests on Kaua'i and Maui that clay hardpan formation may be involved in this dieback and the formation of Hawaiian bogs." While Fosberg states that "weathering of the basalt under cool, very wet, conditions that permit the accumulation of humus and thus percolation of humic acid solutions yields clay" neither he nor Mueller-Dombois et al. (1977) address the question of why there is a hardpan. In fact, Mueller-Dombois et al. (1977) are somewhat perplexed by the relation of this hardpan formation to 'Ohia dieback, stating "it seems hard to believe that one may witness stand-dieback as being caused by a pedogenic or geomorphological phenomenon. Such processes are considered to proceed on a much longer time scale than a tree generation." The fact that hardpan is reported in dieback areas on Kaua'i, Maui and the Big Island, that is, on substrates of similar origin but of vastly different ages, would indicate that this hardpan formation is not a geomorphological process, but the result of processes originating concurrently with the origin of the dieback.

Mueller-Dombois (1978) in his review paper on fire in the tropics, states (as quoted previously) "in larger-sized forest conversions, there is rapid site degradation in tropical rain forest areas in terms of ...soil physical properties (particularly ironstone formation)." Budowski (1966) states that following fire in tropical areas "there is often a deterioration of structure due in part to the dismembering of soil aggregates resulting in clogging of the porous space. The end result is often compaction and a formation of a hard or indurated pan." Thus, fire could be the explanation for the presence of hardpans in dieback areas, and again Vogl (1969) presents evidence of extensive fires on Kaua'i and Maui (which were not reported here) as well as in the Hamakua area of the Big Island, all within the last 80 years.

3). The presence of trunk sprouted trees is reported on certain dieback plots (Mueller-Dombois et al. 1977). Vogl (1969) seems to feel that this trunk sprouting is possibly an adaptation to fire, although he also states that any disturbance could probably produce the trunk sprouting. Mueller-Dombois (1978) feels that trunk sprouting is primarily an adaptation to ash fallout from volcanic eruptions, since remarkable recoveries by 'Ohia and other indigenous plants were observed following the Kilauea Iki eruption. Smathers (1969) in a study of the Hi'iaka Fire Burn area reports however, that nine months after the burn "the native Ohia Tree (Metrosideros polymorpha) was the sole representative of the

phanaerop layer" and that "many trees and shrubs that first appeared to be dead had now begun to develop green buds along their charred stems." would appear then, that 'Ohi'a has an adaptation to resprout from the trunk following mechanical disturbance, whether the disturbance is ash fallout or fire. Although the trees that have recently resprouted from the trunk are probably responding to neither of these stress factors, in areas far from recent ash-fallout disturbance where 'Ohi'a is resprouting, the possibility that the trunk-sprouting is a response to fire should be investigated, especially in areas where the historical records shows a past occurrence of fire.

4). The presence of "sedges, rushes, other bog plants (including *Sphagnum vitianum*), some broomsedge (*Andropogon virginicus*), and the creeping uluhe fern (*Dicranopteris linearis*)" in treeless and stunted-'Ohi'a bogs of the Bog-formation dieback, as well as the observation that the wetland dieback "seems to stop whenever there is a major change in habitat" (Mueller-Dombois et al. 1977). This sounds somewhat like the situation in the wet grasslands of Sri Lanka, as described in Mueller-Dombois (1978). "The talawa grasslands are anthropogenic grasslands in the humid lowlands which originated from shifting agriculture in the rain forest. They are maintained by frequent fires and include the "Kekilla" fernlands, which are covered with *Dicranopteris linearis*." In the wet patana, "the grass fires ... do not normally spread into the adjacent montane rain forest. They stop sharply at its border where one finds usually a narrow ecotone consisting of shrubs and ferns. However, occasionally even this ecotone community becomes burned and a few trees at the forest border are scorched. It is conceivable that the rain forest has given way in this manner very slowly to the grassland by scorching and killing a few trees at a time." Since the probability of a fire occurrence in a given area "is not just dependent on the frequency of ignition events in that stand, but also on the likelihood of fire moving in from neighboring stands" (Christensen 1978) it would appear that where the sedges and uluhe got started following the severe fire, there are now more frequent fires which are converting the former forest to a sedge bog. Or, as Christensen (1978) describes the possible origin of the grass sedge bogs of the south east U.S. - "Such bogs may also result from very intense fires in areas of considerable peat accumulation during dry periods. Such fires may burn the peat below the mean annual water table creating a perennially moist depression which is rapidly invaded by herbs. Because the litter produced by these herbs is rather combustible, fires may be comparatively frequent. Thus, once established, grass-sedge bogs may be perpetuated by virtue of this change in fire cycle."

The hypothesis concerning the possible role of fire in Wetland and Bog-formation Dieback, then, is as follows: An intense fire went through the 'Ohi'a rain forest sometime between 50 to 100 years ago, leading to a depletion of the area of a very substantial proportion of its nutrients and causing hardpan formation in certain area. The fire also destroyed the forest canopy, allowing shade intolerant species, in most cases 'Ohi'a, to invade. Some areas, however, because of the proximity of a seed source, the depth of the burn in relation to the water table, or perhaps because of a change in the fire cycle such that 'Ohi'a could not establish, were invaded by herbaceous vegetation and are today areas referred to as Bog-formation Dieback.

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* Figure 1 from this article was inadvertently omitted from the paper. It is printed on the reverse of this index.

[illegible]

Figure 1. Map of the study area showing the major geographical features of the crater.

In areas where 'Ohi'a did get established the trees grew for a considerable period, perhaps 50 years, until the few remaining nutrients of the site were tied up in biomass. Of course during this growth period the populations were increasing the total nutrient reserves of the ecosystem slightly by trapping any new atmospheric deposits. Eventually, however, the nutrient deficit, coupled with the increasing demands on the nutrient reserves due to competition, overwhelmed the population, causing it to collapse. As an ecosystem function, however, this collapse is beneficial, as the death and decay of trees, which is now under the control of a stable population of microorganisms, will release the nutrients slowly and more directly to the new, 'Ohi'a-regeneration population. In effect, die-back and the microorganism controlled mineralization allows the ecosystem to build up its nutrient reserves, since not only have some nutrients been added by atmospheric inputs, but they are also less susceptible to runoff and leaching. That is, since the "pioneer" species of this ecosystem does not fix N_2 , it first "immobilizes" the nutrients and then more permanent vegetation-microorganism-animal systems develop that can efficiently utilize the nutrients mineralized from excessive populations of microorganisms and pioneer plants (see pgs. 6 & 7). The fact that 'Ohi'a is both the pioneer species and the dominant species of the more permanent vegetation, as well as being a tree, makes this ecosystem function a bit more complicated.

And indeed, this cycle of nutrient uptake, dieback, and controlled nutrient release may be the only way for a natural 'Ohi'a rain forest ecosystem to replenish the nutrients lost in a catastrophic fire, and the cycle will be repeated until the ecosystem is back to the nutrient budget it had before the fire, which, in the absence of N_2 fixing seral stages may indeed take centuries, as Woodmansee and Wallach imply (see pg. 7).

LIGHTNING IN HAWAIIAN RAIN FOREST ECOSYSTEMS

That lightning occurrence in Hawai'i is not a rare event is almost an agreed upon fact. Vogl (1969) and Mueller-Dombois (1978) both accept the figure of 30-50 lightning days per year as reported by Price (1968), who also stated that they are most frequent between October and April. Mueller-Dombois (1978) states also that "the lightning frequency in Hawaii corresponds closely with that of the south east U.S., which is known as a natural fire region." However, the purpose of this section is not to examine the probability of lightning caused ignition events but to look at the other possible effects of lightning on tropical rain forest ecosystems.

But first, where do most of the lightning discharges occur? Vogl (1969) gets his information from Blumenstock and Price (1967) and states that "thunderstorms are usually concentrated in island interiors in the higher mountains and along windward slopes." This would seem to indicate that the lightning discharges are concentrated over areas of rain forest.

Also, from September 1967 to April 1968 Vogl (1969) recorded 55 active thunderstorms, plus 44 thunderhead cells that were not observed to produce lightning. Lightning counts were made throughout the course of 25 storms. The storms averaged 37 electrical discharges, ranging from only 1 to at least 200 strikes per storm. Several storms averaged one strike per

minute for as long as 30 minutes. All but three were accompanied by rain, which was often steady or torrential.

LIGHTNING EFFECTS ON ECOSYSTEMS

Aside from being the most prevalent natural fire ignition source worldwide, what are the effects of lightning on ecosystems, particularly rain forest ecosystems? According to Brunig (1964) and Anderson (1964) working in the Shorea albida rain forest in Sarawak, gaps in the canopy of the Shorea dominated rain forest are attributable to lightning damage. Anderson (1964) states that "initially the cause of group mortality of Shorea albida was purely conjectural, but after a study of the groups of dead trees and a review of the literature the damage can be safely attributed to lightning. This confirms the opinion of many of the local Ibans and Milanaus who traverse the peat swamp." Brunig (1964) states that "in all areas (examined on air photos) the pit like gaps were found to be a characteristic feature of the Shorea albida forests."

The following are characteristics of lightning damage in the Shorea rain forest: "The gaps in the canopy are usually approximately circular in shape; damaged trees have a distinctly whitish-grey tone before defoliation; the bare trees remain conspicuous for some years after defoliation; and the largest gaps have a diameter of between 4 and 5 chains (264-330 ft.) covering areas up to an acre and a half (Brunig 1964, Anderson 1964). Anderson also reports that "on some trees half the crown was killed, whereas damage on other trees was confined to one branch or even part of a branch. Almost invariably the damaged part of the crown faced towards the dead trees."

Further characteristics enumerated by Anderson (1964) are as follows:

-Damage is most severe in the Shorea albida consociation where the canopy is pure and even.

-Trees exceeding 50 in number may be killed or damaged by a single strike where the canopy is even, but in forest with an uneven canopy damage is largely confined to emergents and a few middle- and lower-storey trees in the vicinity of the killed emergents.

-The intensity of the damage is greatest at the focal point, which is usually near the center of the group. (But) beyond the margin of the group (of damaged trees) the occasional tree may be slightly damaged.

-Regeneration of Shorea albida was almost absent under the undamaged canopy outside the groups, and only the occasional seedling was found in the three older groups of damage. In the recent groups, however, regeneration both of seedlings and small saplings was abundant and appeared vigorous.

Brunig (1964) states that "evidence of a second hit by lightning in 11 of the 28 gaps examined, and an apparent but not yet tested tendency of gaps to occur in groups or clusters may indicate that certain localities may attract lightning more than others, possibly as a result of a favorable coincidence of a number of physiographic, edaphic, climatic and biotic factors." Along these lines, Anderson (1964) states that "the

severity of damage in any locality is dependent on a number of factors among which may be mentioned: 1) Frequency and intensity of lightning storms. 2) The structure of the forest. Forest with a pure, even canopy, especially where it is composed of a single species, is liable to greater damage than a mixed forest with an uneven canopy. 3) Topography of the ground. More severe damage, in numbers of trees killed or damaged is expected to be where topography is flat. 4) Species of tree. Certain species are probably inherently resistant to lightning damage and/or have greater ability to recover from such damage."

Taylor (1974) commenting on the literature on lightning damage states that "tree group mortality of this type has seldom been reported in the United States and Canada but has commonly been observed throughout Europe, in England, Scotland, Australia, New Guinea, and Malaysia." He also states that "the physiological lightning effects least understood are those attending mortality of tree groups," but goes on to say that "...of greater biological significance is that the direct structural and physiological effects of lightning are precursory to other physical events in the environment and to important biological activities by consumers and decomposers."

He expands on this in the following paragraph:

Forest entomologists are aware that individual conifers damaged either by lightning or other injurious agents attract several genera of scolytids (bark beetles). Sharpening this awareness, Anderson and Anderson proposed that pioneer flights of *Ips* bark beetles are attracted to lightning-struck southern pines by volatile oleoresin fractions released from ruptured bark and wood tissues. Then ...attacks by a few pioneer beetles on a single lightning struck tree may trigger mass attacks on the struck tree and its neighbors. Providing more recent evidence of this, Hodges and Pickard have reported that individual lightning struck pines were epicenters for 31% of the 2100 tree-group beetle infestations recorded in a three year period on one large ownership in Louisiana.

Lightning produces a shower of finely divided bark, wood and needle particles, which is deposited on neighboring trees to a radius of 50 m or more from the struck tree (Taylor 1974). He continues "the debris shower, in effect, places a multitude of minute, short-term oleoresin releasing sources on and around the struck tree and its neighbors. An especially dense shower might enhance the probability of discovery and attack by pioneer beetles in an otherwise marginal olfactory-search situation."

Could these lightning strike events be happening in the Hawaiian rain forest? It certainly seems to have most of the characteristics set forth by Anderson (1964) (see pgs. 15 & 16). But Vogl states that "lightning struck trees or lightning damaged vegetation were not found on trips into Oahu mountains. Split, broken, or fallen trees were encountered, but could not be definitely linked to lightning, since characteristic spiral trunk splits common on mainland trees were not observed. Perhaps tropical trees are not affected by lightning in the same way." According to Anderson (1964) this certainly would seem to be the case, at least for the species present in Sarawak. He states that "...all trees have been examined for some of the more usual evidence of lightning damage, such as shattering or splitting of the bole, charring of the bark, etc. Only on

one tree (of 102 killed) was there any real evidence, and even here it was difficult to say whether it was caused by lightning or merely a secondary effect. This general absence of direct manifestation of lightning damage is not unusual." On a more general note, Taylor (1974) in summing up, states: "We have seen that although the influences of lightning in forest communities may sometimes be obvious, more often they are subtle and go virtually unnoticed."

THE RELATION OF LIGHTNING TO 'OHI'A DIEBACK: A HYPOTHESIS

There are two facts of 'Ohi'a dieback, more specifically dryland dieback, that could possibly be explained by the effects of lightning on the 'Ohi'a rain forest.

1). On air photos the Dryland dieback type shows a "pocket"-like distribution. These pockets are usually less than an acre to rarely more than an acre in size, and some appear to be associated with dense 'Ohi'a stocking (Mueller-Dombois et al. 1977). These characteristics are similar to Brunig's (1964) and Anderson's (1964) description of the *Shorea albida* rain forests of Sarawak. That lightning strikes do occur in Hawaiian rain forest areas has already been shown (Vogl 1969, pg. 14). Furthermore, Mueller-Dombois et al. (1977) describe one small dieback area that could have been the result of a recent lightning strike. "The dieback pocket was too small for mapping it as an open forest at the chosen map scale. Interestingly, there are a number of recently dead standing trees, but no old snags. This stand must have died very suddenly and recently."

2). Papp et al. (1979) report the results of an entomological study in dieback areas. They state that "neither (the 'Ohi'a wood borer) *Plagithmysus bilineatus* nor (the fungous root pathogen) *Phytophthora cinnamomi*, acting alone or in combination, can be considered primary incitants of epidemic ohia decline as described by Petteys and others (1975). However, the presence of *P. bilineatus* and its intensity of attack ...are clearly associated with declining 'Ohi'a trees on eight widely differing sites on the island of Hawaii." Of particular interest here is the wood borer, about which they state "our results suggest that it accelerates the decline of predisposed trees." They report that data analysis indicates that site related factors are probably involved in the relationship between declining crown condition and *P. bilineatus* attack, and that less than 15% of healthy trees at any site were attacked, while 75% of the severely declining trees were attacked. Also, attack by the wood borer "was apparently encouraged by rootlet mortality or crown loss brought on by unknown stress factors." If we can accept that lightning strikes are not a rare occurrence in the 'Ohi'a rain forest and Taylor's (1974) statements about lightning being a precursor for certain biological events, particularly bark beetle attack, the results reported in Papp et al. (1979) fit in very nicely with the effects of lightning in other ecosystems around the world.

The hypothesis in the case of lightning, then, is that in areas of the 'Ohi'a dominated rain forest where there is an even canopy, lightning strikes cause groups of 'Ohi'a trees to die, which gives the Dryland dieback its pocket-like appearance when examined on air photos. This lightning induced group death opens up the canopy, allowing regeneration of 'Ohi'a in these areas. Some volatile substance in 'Ohi'a is released

in the area of this lightning event, attracting the 'Ohia wood borer. This type of die-back, of course, has been going on since 'Ohia became the dominant forest tree on the Islands, and given the dogma of the coevolution of insects and their plant hosts, it is to be expected that the wood borer present at dieback would be endemic.

CONCLUSION

The facts of 'Ohia dieback explained by the occurrence of a fire in the past and by the effects of lightning on ecosystems would tend to indicate that the hypotheses presented here have some validity in the real world and are indeed worth testing.

Of course, in nature the effects of lightning and the effects of fire are often not as easily separable as they are on paper. Also, what is called Wetland 'Ohia dieback and Dryland 'Ohia dieback are also probable not as easily defined in the field as they can be arbitrarily on paper. That is to say lightning, both as an incendiary event and in its role as other than an ignition source, probably is a factor in all three types of 'Ohia dieback discussed here - Wetland dieback, Dryland dieback and Bog-formation dieback. Fire, on the other hand, probably plays a continuing role in Bog-formation dieback, but its role in Wetland dieback is restricted to a historical role, and it can only be a minor factor in Dryland dieback.

It is believed that these two hypothetical triggers, interrelated though they may be, occur independently enough over time and space as to fulfill the requirement that 'Ohia dieback is caused by more than one trigger. For, as Mueller-Dombois et al. (1977) states, "...it appears now, in view of our findings, untenable to consider the 'Ohia dieback as caused by a single trigger."

If these hypotheses could be considered to be theories, since they do incorporate a number of facts, this would provide some concrete management objectives - mainly to somehow keep fire out of the rain forest. Also to try to attempt to minimize the effects of recurrent fires, perhaps by suppression, in those areas already tending away from 'Ohia rain forest. The effect of lightning, even as an ignition source, is, of course, unstoppable. The implications are many, but it is feared that the invasion of exotic grasses into certain dieback areas gives a new aspect to seral development in the 'Ohia forest.

ACKNOWLEDGEMENTS

A reference list does not indicate which works were most instrumental in the formulation of ideas. In this regard, both Mueller-Dombois et al. (1977) and Mueller-Dombois (1978) played major roles, and it should be pointed out that the references to the effects of lightning in rain forests (Brunig 1964, Anderson 1964) were originally found in the references given in Mueller-Dombois 1978.

I would like to thank Dr. Cliff Smith and Dr. Sanford Siegel for their comments and help in moving this paper from the rough draft to the finished form. Also, Dr. Dieter Mueller-Dombois and Dr. Charles Hodges,

as well as the aforementioned gentlemen, made valuable comments and suggestions concerning the justification and viability of the hypotheses presented. Not all of the suggestions were incorporated, however, as it was felt that some of them would be better presented in print in response to this paper; that is, to get some further facts of 'Ohia' dieback into the light. Be that as it may, the ideas presented in this paper are the complete responsibility of the author.

Hopefully, the exchange of ideas and the cooperation encountered in writing and presenting this paper will carry over into further studies of the 'Ohia' decline phenomenon.

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LETTERS TO THE EDITOR

1 February 1979.

Members of the Tamaricaceae, the tamarix family, are unusually successful in arid habitats because they are highly adapted to coping with the adverse conditions. Several deserts have very saline soils, and those plants capable of dealing with the excessive salt are at an advantage. Tamarix, for instance, is capable of secreting salt through special glands in its leaves. Even where conditions are not excessively saline the secretory system in Tamarix is remarkably effective. In one analysis, the secretions of Tamarix aphylla grown in a solution of known concentrations of salt were shown to be, on the average, 50 times more concentrated than the growth solution (Berry, W. C. 1970. Characteristics of salt secreted by Tamarix aphylla. Amer. J. Bot. 57:1226-1230).

The use of Tamarix in soil conservation plantings in the Hawaiian Islands should be reconsidered. While it certainly provides greenery when grown in arid areas, it may also interfere with the establishment and growth of forbs which are often more important than tree species in soil conservation. The effectiveness of Tamarix should be evaluated before large scale plantings are made. Quite apart from the possible interference with the growth of useful soil binding grasses, such as the native pili (Heteropogon contortus) and the exotic buffel grass (Cenchrus ciliaris), Tamarix has escaped in many areas of the world where it has been planted and become a noxious weed in several habitats, for example stream and river banks. There are more than enough exotic weed problems in the Hawaiian Islands without adding another to the list. The introduction of Tamarix should be carefully monitored and appropriate action taken if it does not act as a good soil conservator or it shows signs of escaping into other habitats.

Lani Stemmermann
Volcano, Hawaii

RECENTLY COMPLETED THESES

IN BOTANICAL SCIENCES

AT

THE UNIVERSITY OF HAWAII

WONG, Diana C. L. 1975. Algae of the anchialine pools at Cape Kinau, Maui, and aspects of the trophic ecology of Halocaridina rubra Holthuis (Decapoda, Attyidae).

The taxonomy and distribution of algae in the anchialine pools at Cape Kinau, Maui, Hawaii, were studied with respect to environmental variables. Related work concerned studies of the foods and feeding anatomy of a small atyid shrimp, Halocaridina rubra, which is the dominant primary consumer. The anchialine pools can be separated into four groups based on their algal flora. At one extreme are pools in which matted and crustaceous cyanophyte (blue-green bacteria) communities are characteristic; at the other, are pools dominated by a marine flora consisting of macrophytic chlorophytes and rhodophytes. Intermediate are pools in which marine algae are found along with the cyanophyte communities. The fourth group of pools is characterized by the presence of the phanerogam, Ruppia maritima. Matted and crustaceous cyanophyte communities--Scytonema cinnatum mat, Lyngbya mat, Lyngbya crust--are the most unique components of the anchialine algal flora. The Scytonema and Lyngbya mats are comparable to similar communities described in the literature and the Lyngbya crust is likened to organosedimentary structures delineated in many studies as algal laminated stromatolites or algal laminated sediments. Inorganic material associated with cyanophyte communities was identified by X-ray diffraction as calcium carbonate in the form of aragonite. It is postulated that these sediments are biogenic and autochthonous--that they are precipitated in situ by the cyanophyte communities as no allochthonous source is apparent. Salinity was identified as a major factor affecting the distribution of algae; other influencing factors were substratum, insolation, and tides and wind. Analyses of Halocaridina rubra gut contents indicated that the major component of its diet consisted of an amorphous mass of greenish-brown material composed mainly of organic detritus. Lyngbya sheaths and diatom frustules were the most prominent among identifiable materials ingested. H. rubra generally feeds on bottom materials but also was observed feeding in midwater in pools with abundant phyto-plankton such as Gymnodinium. It is primarily a chelate raptatory feeder. A maxillary filtratory mechanism is postulated circumstantially to be involved in the feeding of phytoplankton in the water column.

FLOYD, Mary E. 1977. Autecological study and phenolic analysis of Pelea anisata Mann (Mokihana).

Pelea anisata Mann (Rutaceae) or Mokihana, is endemic to the island of Kauai where it is an important component of Metrosideros dominated forests. This study investigated aspects of its reproduction and phenolic chemistry. First, a structural analysis of seven sites in the Koke'e area demonstrated that Mokihana is successfully reproducing in its natural environment. Secondly, attempts were made in the laboratory to germinate

P. anisata seeds using scarification, chemical treatments (i.e., potassium nitrate, thiourea and gibberellic acid), and alternating light and temperature conditions. All attempts failed, however the presence of germination inhibitors was detected and it is speculated that the failure of germination may be due to accumulation of such inhibitors under laboratory conditions. Finally, the phenolic constituents of Pelea anisata as well as five other Pelea species were extracted and chromatogrammed using thin layer chromatographic techniques. The thin-layer chromatograph finger-print of each species was significantly different from that of the others. Thus, it is proposed that fingerprints of the phenolic constituents of Pelea species may have chemotaxonomic value.

FOTOS, Sandra S. 1978. Observations on the cytology and life history of Chnoospora minima (Hering) Papenfuss (Scytosiphonales, Phaeophyta) in the field and in culture.

In the Hawaiian Islands the species Chnoospora minima exhibits the morphological features accepted for the order Scytosiphonales. Its placement in the order is thus supported. A dimorphic alternation between an erect blade and a small disc has been observed in culture. The disc shows a direct return to the erect blade independent of temperature or photoperiod. In addition, culture studies have demonstrated the ability of the discoid phase to perpetuate itself for a number of generations, apparently by means of swimmers released from fertile areas on branches of limited length, termed knot filaments, produced by the disc. A limited field study supports the findings that the discoid phase perpetuates itself, and thus, the species as well, at a given site. It is suggested that self-perpetuation by the discs is of importance in maintaining a field population of Chnoospora minima during the winter months, when adult thalli are frequently removed by strong wave action.

FUNK, Evangeline J. 1979. Anatomical variation of fibers in five genera of Hawaiian Urticaceae and its significance to ethnobotany.

An anatomical examination of five genera of Urticaceae has shown that the cells of Urera and Touchardia used by the early Hawaiians for fiber are actually thick walled branching non-articulated laticifers. At maturity these cells become lignified, a process which begins in younger tissue in Urera than in Touchardia. They are apparently the only laticifers known to have been used as commercial fibers. True fibers are distributed unevenly along different radii of the stems of Neraudia, Boehmeria and Pipturus. This variation may represent a response to external conditions such as prevailing winds and seems analogous to the formation of reaction wood. The bark of Pipturus, when placed in water, exudes large quantities of an adhesive material that was probably as valuable to the aboriginal Hawaiians for cementing layers of tapa together as the fibers were in forming the substance of the tapa. Experiments suggest the usable fibers of Pipturus were apparently extracted from the bark by scraping and probably never obtained by retting.

MCKENNA, Dennis J. 1979. Biochemical markers in Hawaiian and extra-Hawaiian Acacia species.

This study focused on certain aspects of the secondary biochemistry of the endemic Acacia species and several closely-related extra-Hawaiian Acacia species. Thin-layer chromatographic methods were developed for analyzing the soluble amino acids of seeds and seedlings, and for analyzing the phenolic fractions of phyllodes. Three phenolic fractions from phyllodes of A. koa (Koa) were isolated and partially characterized using reagents and spectral analysis. The major constituents of the soluble amino acid fraction of Koa seeds were identified by comparison with standards. Systematic comparisons of the soluble amino acid thin-layer profiles of the Hawaiian Acacia species and eight closely-related extra-Hawaiian species were carried out using seeds and 120 day old seedlings. A developmental study of the changes in the soluble amino acid profile of Koa, from 0-240 days of age, was also carried out. A compound similar to 3-hydroxyproline was detected in the seedling profiles and was characterized by chromatographic methods. Other aspects of the work included bioassays of albizzin and S-carboxyethylcysteine, which are major components of the soluble amino acids of Koa seeds, and a test for the presence of alkaloids in the species sampled.

BECKER, Richard E. 1976. The phytosociological position of tree ferns (Cibotium spp.) in the montane rain forests on the island of Hawaii.

Tree ferns form a very conspicuous component in the montane rain forest communities on the island of Hawaii. This study has been concerned with the identification, nomenclature and phytosociology of these Hawaiian tree ferns. A literature survey deals with the taxonomy, geographical distribution, habitats, and physiological studies of tree ferns, with the emphasis on Cibotium species. It then deals with the concepts and methods involved in a vegetational study, followed by a review of aspects of competition and the stability role of tree ferns in the montane rain forests. This part is concluded by sections on myths and uses of tree ferns. The second chapter clarifies the nomenclature of the six Hawaiian Cibotium species. A key and descriptions are given for these species together with their island distributions. The species recognised are Cibotium chamissoi Kaulf., C. glaucum (Sm.) Hook. & Arn., C. hawaiiense Nakai & Ogura, C. nealiae Degener, C. splendens (Gaud.) Krajina & Skottsbo. and C. st.-johnii Krajina. The next chapter begins with a detailed section on the field methods used to collect tree fern measurements and floristic data. A minimum sampling area of 1,200 square meters was found to be necessary to record at least 90% of the plant species. The detailed tree fern measurements, and the data from the twenty vegetation releves were processed by computer. The information obtained from the computer analysis was used to ordinate the vegetation types based on the morphological variability of the trunks and fronds of the dominant class Cibotium glaucum. This is perhaps the first time that the morphology of a single species has been used to ordinate a set of vegetation types. The derived ordination was supplemented with other data from the tree layer and substrate types to develop an ecological series of vegetation types. This series of types was supported by the analyses of the floristic data. These were done using dendrograms and two-way tables. The former showed that the types could be further aggregated together by more generalized structural and floristic criteria, to give three broad

categories of vegetation. These are: 1) the scrub and open Metrosideros types with Gleichenia (Dicranopteris) fern, 2) the Acacia koa types, and 3) the closed canopy Metrosideros forests. The two-way table analyses yielded twenty-one species groups specific to different sets of releves. The groups were often formed of species of similar life forms, one species groups was also formed by species principally of exotic origin. Several native tree species were found to be absent as seedlings in the herbaceous layer. A detailed stand structural analysis of the vegetation types showed that Cibotium glaucom is maintaining itself in all size classes. Its modes of reproduction are by spores and by rooting of trunk buds. Both methods are predominantly features of the most dominant individuals. Cibotium chamissoi was the less common species in the sampled vegetation types. In comparison to Cibotium glaucom, C. chamissoi appears to depend more on spore reproduction than on the establishment of trunk buds, although both methods are also used by this species. Cibotium chamissoi was also more abundant in the epiphyte niche than C. glaucom. An experiment was done to show that artificial regeneration of tree ferns onto open pasture land is easily accomplished. In this way the re-establishment of native forests could be initiated. It was postulated that the montane rain forest types resemble more of a fluctuating network of types rather than a simple linear series. Through this network of vegetation types, primary succession no doubt ebbs and flows, but its exact courses are yet to be charted. The last part of this dissertation contains appendixes of supplementary materials. These include notes on the herbarium material examined, a partial checklist of the vascular plants of the montane rain forest, and a glossary of technical terms. The work is completed with the bibliography which contains entries for each of the citations in the entire work.

ALLENDER, Bruce M. 1976. Ecological aspects of some Hawaiian species of the Dictyotales with special reference to Padina japonica Yamada.

Fifteen species of the Order Dictyotales (Phaeophyta) occur in Hawaii. They are Dictyopteris australis, D. plagiogramma, and D. repens, Dictyota acutiloba, D. crenulata, D. divaricata, D. friabilis and D. stolonifera, Lobophora variegata, Padina australis, P. sanctae-crucis, P. thivyi and P. vickersiae, Spathoglossum schroederi and Taonia hawaiiensis. The responses of six of these species to several physical environmental factors are presented. Reef populations of the species of Dictyotales are dominated by the sporophyte phase of the life history at different reef sites and at all seasons. For P. japonica, an explanation of this phenomenon apparently involves differences in the growth rates and structural strengths of the adult sporophyte and gametophyte phases. The numerical superiority of the sporophyte over the gametophyte generation may be attributed to more rapid adult growth in the local water temperatures and to greater longevity (less prone to destructive water movements), both of which provide a competitive advantage to the sporophyte in the established populations of the species. All six species have seasonal variations in standing crops, and there is evidence that single factors rather than complexes of factors cause these changes. For at least four of the species, experimental growth rates under controlled conditions support the relationships predicted from the field data. P. japonica is a heliophyte with maximum growth in the summer season of high illumination. Dictyota divaricata has maximum standing crops in autumn, while Dictyopteris plagiogramma and Dictyota

crenulata have maxima in autumn-spring, probably because the growth rates of these three species are strongly temperature dependent. With the exception of the prostrate form of L. variegata, the other five species are erect frondose forms and show similar experimental growth responses to water movement gradients. P. japonica can tolerate intertidal emersion, but growth rates are depressed compared with subtidal conditions. The duration of emersion tolerated by the species is temperature dependent. Experiments with the prostrate, juvenile phase of P. japonica suggests that survival of the species is increased because this phase tolerates a wider range of physical conditions than the adult fronds.

HWANG, Shin-chuan. 1976. Phytophthora cinnamomi: Its biology in soil and relation to ohia decline.

The population of Phytophthora cinnamomi in soils and the amount of ohia rootlets infested with this fungus were determined at four locations, each with healthy and decline forest located close together. The fungus was detected in 34% of soil samples collected from healthy areas and 29% of those from decline areas. The average population of the fungus in healthy areas (0.1-1.7 propagules/g soil) was not significantly different from that in decline areas (0.1-2.2 propagules/g soil). About 37% of declining trees and also 37% of healthy trees had rootlets infested with the fungus. Declining trees had an average of 5.2% rootlet segments infested with the fungus, and healthy trees had 9.4% with this fungus. For a total of 199 ohia trees surveyed, there was no correlation between percentage of rootlets infested with the fungus and severity of tree decline. There was no indication that the fungus in decline areas was more pathogenic than that in healthy areas. These results suggest that the fungus is not a major cause of ohia decline. By contrast, in avocado tree decline caused by the fungus, the population of the fungus in soil collected from the root zone of declining trees was significantly higher than that collected from healthy trees. The fungus was isolated from 97% of the declining trees. Moreover, the severity of tree decline was directly correlated with the percentage of roots infested with the fungus. Declining trees had an average of 29.2% of root segments infested with the fungus while healthy trees had only 8.7% with this fungus. Colonies of the fungus recovered from natural soil originated mainly from chlamydospores, and occasionally from zoospores. Chlamydospores occurred as free spores or imbedded in organic matter. Results of this study indicated that sporangia of the fungus also existed in natural soil, and zoospores found on the isolation plates were released from sporangia during incubation. Among the three spore types of the fungus tested, chlamydospores were the most persistent in soil, sporangia were intermediate, while zoospores were the least persistent. Survival of the fungus in soil was better under moist than submerged conditions. The population of chlamydospores remained detectable for one year in moist soil, while only for 3 months in submerged soil. Similarly, over a 12-month period the population of the fungus in a naturally infested avocado soil declined faster under submerged than moist conditions. Results of survival studies also showed that the fungus in the root tissue was more persistent than as free chlamydospores in soil. Under moist conditions the percentage of root tissues from which the fungus was recovered declined only slightly after one year of incubation, while the population of chlamydospores in soil

decreased to undetectable levels in the same period. The fungus is a good saprophyte. It was able to colonize about 52% of ohia stem segments at a population as low as 10 chlamydospores/g of soil. Among the three spore types of the fungus tested, chlamydospores were also the most effective in colonizing dead ohia stems, while colonization potential of motile and encysted zoospores was about the same. Motility of zoospores is important in disease development. At inoculum level of 2,500 propagules/g of soil or above, encysted zoospores were the least infective to ohia seedlings, while infection potential of chlamydospores and motile zoospores was about the same. At inoculum levels below 2,500 propagules/g of soil, however, no significant difference in infection potential was found among these three spore types tested.

WIRAWAN, Nengah. 1978. Vegetation and soil-water regimes in a tropical rain forest valley on Oahu, Hawaiian Islands.

This dissertation is concerned with the correlation of vegetation patterns and soil-water regimes in a tropical rain forest area in Kahana Valley, Oahu, Hawaiian Islands. For determining the influence of spatial variation in soil-water regimes on the vegetation patterns, the soil-water regimes of each of 64 sample stands were determined from the combined effects of rainfall, topographic position, soil depth and structures by an equation. In this way a soil-water regime gradient was identified over which the plant species distribution patterns were plotted. For this plotting three methods were used, a dendrograph cluster technique, a two-way synthesis table technique and a single dominant species analysis. Seven segments along the soil-water regime gradient were identified (i.e. moderately dry, fresh, moderately moist, very moist, wet and very wet). Except for the very wet soil-water regime which occurred along streams, the other six regimes were indicated through species distribution and community patterns. However, not all species distribution patterns were related to these soil-water regimes. For example, the distribution of Aleurites moluccana to the gulches appeared to be influenced primarily by mechanical forces (rolling rocks) that crack the hard coat of seeds of this species. The study also revealed an explanation for the restricted distribution of Acacia koa, which was found only on moderately moist or occasionally dry soils. For determining the degrees in which different plant covers may modify a particular soil-water regime, detailed investigations on the physical characteristics of the soils and the fluctuation of soil-water contents under paired plant covers with contrasting structures (herb vs. tree covers) were carried out. In general, where the tree species (Brassaia actinophylla and Eugenia cumini) invaded the Andropogon virginicus grass cover, the tree covers did not alter the soil-water regime of the grassland significantly. In the case where the tree species (combinations of Acacia koa and Pandanus odoratissimus) could have been established at about the same time as the herbaceous Dicranopteris linearis fern cover following the destruction of the original vegetation, the soil-water regime under Acacia-Pandanus was drier than under Dicranopteris. This indicated a greater loss of water to the atmosphere from the Acacia-Pandanus than from the Dicranopteris covers. The difference in the intensity of soil drying or the magnitude of water loss was also related to better soil aggregation and greater volume of macropore space under the tree than under the herbaceous fern covers. As

better aggregation encourages faster internal drainage of soil-water and consequently a more rapid recurrence of saturation deficits between showers, greater volume of space is available for storing the rain water during the storm periods. Under similar rainfall regimes, such a difference tends to bring about greater surface runoff or stream flow from the herbaceous than from the tree covers. Furthermore, since much of the ground water and the stream water are actually gravitational water that is stored temporarily in the macropore spaces during rain shower activity, this difference will also result in a greater water yield from watersheds covered with trees than watersheds covered with herbaceous fern species. Thus, in a tropical rain forest, where excessive water is often a problem, plant covers that dry the soil with greater intensity or lose more water to the atmosphere are preferable for flood control.

WHITEAKER, Louis D. 1978. The vegetation and environment of the Crater District of Haleakala National Park.

A vegetation map of the Crater District of Haleakala National Park was produced at a scale of 1:24,000 which can be used as an overlay of the USGS 1:24,000 topographic quadrangle maps. Fifty-three structural-floristic communities were mapped which were grouped into four structural vegetation-types. These were forest, scrub, grassland and high altitude desert. Areas were calculated for each community using a planimeter. The total area mapped was 7544.8 hectares (18,643 acres). Topographic vegetation profiles were constructed which show changes in vegetation-types in relation to climatic gradients. Also, matching correlations were observed between certain substrates and community-types. Phytosociological analysis of releve data by the synthesis table technique and the dendrograph technique resulted in ecologically meaningful groupings of the sample stands. Both analyses resulted in similar groupings. Detailed comparison of the grouping results of the two methods revealed interesting minor variations. Some releves were left ungrouped. These were interpreted as ecologically unique within the sampling area. The hypothesis that the community-types that are characteristic of other tropical alpine and subalpine ecosystems occur in the Crater District of Haleakala National Park was partially supported by the map units and phytosociological analyses of the releve data. Ericaceous scrub, tussock grassland, and high altitude desert occur as mappable vegetation units. Only arborescent and rosette life forms did not occur as mappable units. However, a rosette life form, Argyroxiphium sandwicense, does occur in the study area and may have had a wider and more abundant distribution in the past. The hypothesis that the vegetation map of the Crater District of Haleakala National Park has similar vegetation units and vegetation-types as those mapped by Mueller-Dombois and Fosberg for the tropical alpine and subalpine ecosystem on the slopes of Mauna Loa in Hawaii Volcanoes National Park was supported by a comparison of the two maps. Variation of the vegetation within the study area was shown to be associated with variations in climate, substrate, mechanical influences and the effects of exotic plant species. Climate diagrams confirmed the tropical high montane character of the study area, while they illustrated also the considerable variation of climate within the Crater as well as its seasonal variation. It was concluded that the diurnal frost boundary as indicated by the vegetation should be used to define the lower limit of the alpine zone in tropical high mountain areas. This conclusion implies that the subalpine

zone be defined as those areas below the diurnal frost boundary and above the montane forests and grasslands.

CROSTHWAITE. Leola M. 1975. Hypersensitive Cell Collapse Induced in Bell Pepper (Capsicum Annuum) by Pseudomonas phaseolicola and by an Endotoxin Isolated from the Bacteria.

Electron micrographs of pepper tissue infused with 107 and 108 cells /ml of Pseudomonas phaseolicola, the causal agent of the halo blight of bean, show that after 12 hours the bacterial cells aggregate in a gel-like matrix of electron translucent material on the plant cell walls facing the intercellular spaces. Within the gel matrix an electron dense amorphous material is also observed, but its occurrence depends on the inoculum concentration used to inoculate the plant. In the plant cells adjacent to the localized bacteria a plasmalemmasome first develops, followed by deposition of a wall construction, with cell collapse occurring soon afterwards. Wall constructions and cellular collapse are also observed in pepper tissue infused with a purified extract from the bacterial cells, but not from the culture broth. The purified extract contains a high molecular weight endotoxin which is capable of causing confluent cell collapse that is not accompanied by tissue browning or senescence symptoms. It is degraded by pronase, but not RNase, and has a molecular weight of approximately 93,000. A mutant of Pseudomonas phaseolicola which is incapable of producing halo blight symptoms in its host or producing in culture the inducing principle also possesses the endotoxin which shows similar properties to that of the parent pathogenic strain.

LETTERS TO THE EDITOR

February 14, 1979.

Little is known about the phenology of the endangered Munroidendron racemosum (Forbes) Sherff (Pokalakala) of Kaua'i. Based on two flowering seasons of one cultivar, the following generalizations can be made.

Flowering seasons vary: The first year's flowering was in early spring while the second flowering was the following year in later autumn. The inflorescence which is terminal attained a length of about one meter when fully developed but some only attained a third of that length. New branches develop laterally below the inflorescence. The sepals and petals fell within three days and the stamens followed a day or two later. The fruits matured within 75 days.

This cultivar was half a meter tall when planted and reached sexual maturity four years after germination.

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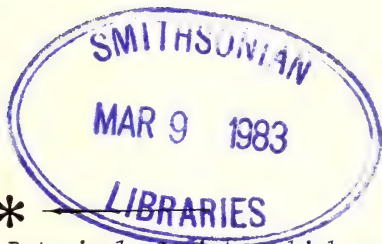


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→ * →
Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

A REVIEW OF THE LITERATURE ON HAWAIIAN ORCHIDS

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The first reference to the orchidaceous flora of the Hawaiian Islands appeared in J. Lindley's "Genera and Species of Orchidaceous Plants" published in 1840. Lindley described a single species of orchid from the Hawaiian Islands. The new species was named Anoectochilus sandvicensis after the geographic location where it was found. Lindley based his new species on a single collection of material deposited in the herbarium of William Hooker at Kew Gardens. Hooker received the specimen from A. Mathews, a well-known collector who traveled extensively throughout South and Central America (Lasegue 1845). How or when Mathews obtained the material from the Hawaiian Islands and where the two plants of A. sandvicensis were collected in the Hawaiian Islands is uncertain. The single sheet deposited at Kew is undated and has no locality data other than the words "Sandwich Isles" written on the herbarium paper to which the plants are mounted. Lindley acknowledges these facts in his notes on the species (Lindley 1840), but provides no additional information about the species other than his brief description of the plant.

Lindley's original description of A. sandvicensis is interesting because the author characterized the species as having a labellum with an entire, non-fimbriate margin. The author made repeated references to this fact in his description and even went so far as to assign the new species to a special section of the genus characterized by taxa with non-fimbriate labella. This character proved to be extremely variable in A. sandvicensis, however, and the majority of later collections of the species differed from the original material upon which the species was based. Lindley was unaware of this inherent variability when he described A. sandvicensis and his oversight in this respect has provided the impetus for a series of later revisions of the genus within the Hawaiian Islands.

Shortly after Lindley's monograph of the Orchidaceae was published, a second species of Anoectochilus was described from the Hawaiian Islands. The new species, A. jaubertii, first appeared as an illustration in Charles Gaudichaud's atlas to the "Voyage autour du monde execute pendant les annees 1836 et 1837 sur la corvette la Bonite" published in 1843. Gaudichaud acted as ship's botanist on the voyage of the Bonite under the command of Captain Vaillant. The voyage was Gaudichaud's second visit to the Hawaiian Islands and he later published an account of the new plants he encountered while on the voyage. Gaudichaud's account included an atlas of plates of the new species he collected on the voyage accompanied by detailed captions. Anoectochilus jaubertii was depicted in great detail in plate 100 of the atlas. The illustration of the species was based on a series of plants which Gaudichaud collected at "Port Byron" (an uncertain locality since the ship never reached Hilo or Byron's Bay) on the island of Hawai'i during the brief visit of the Bonite in October 1836 (Dunmore, 1969). The specimens of A. jaubertii, later designated as Gaudichaud's number 107, were eventually deposited in the herbarium at Paris.

Gaudichaud's illustration of A. jaubertii differed from Lindley's description of A. sandvicensis primarily in the extent to which the mesochile of the labellum was appendaged. In A. sandvicensis (sensu Lindley) the mesochile had an entire, non-appendaged margin, while in A. jaubertii the margin of the mesochile had a series of tooth-like appendages. Gaudichaud did not make reference to A. sandvicensis in his treatment of A. jaubertii and there is some question whether he was even aware of Lindley's species at the time. The two proposed taxa, as originally described, were morphologically distinct from one another, however, and were maintained as separate species by subsequent workers on the Hawaiian flora for over 25 years. It appears that the similarity between the two proposed species was not fully appreciated until additional collections were available for study.

Gaudichaud's A. jaubertii was later discussed briefly by Blume in his "Flora Javae et Insularum Adjacentium Nova Series" published in 1858. Blume, who originally proposed the genus Anoectochilus in his "Bijdrage" (Blume 1825b), later split the genus into Anoectochilus (sensu Blume 1858) and a new genus, Odontochilus Blume (1858). Odontochilus differed from Anoectochilus by having nonvariegated foliage and flowers with labella having sacklike bases. Contrasting this, Blume restricted Anoectochilus to only those species of orchids formerly assigned to the genus which had variegated foliage and flowers with distinctly spurred labella. Anoectochilus jaubertii, which was originally described as having uniformly green foliage and a flower with a sacklike base to the labellum, was a perfect candidate for Blume's new genus. Blume formally proposed that the species be transferred to his new genus in 1858. The author made no reference to A. sandvicensis Lindl. at the time he cited O. jaubertii (Gaud.) Bl. and it is unclear why he omitted the species from his treatment. (Possibly Blume regarded Lindley's species, which had an un-appendaged, entire mesochile as not belonging to either genus and excluded the species entirely pending further investigation, or it may have been an unintentional omission.) Blume's decision, however, to divide Anoectochilus into two smaller genera has been, and still remains, a point of contention among many orchid taxonomists since Odontochilus was first proposed. Many recent authors, including Holttum (1953), Dressler and Dodson (1960) and Seidenfaden (1978), regard Blume's treatment as unjustified and combine both genera under the name Anoectochilus which has priority.

A few years after Blume's comments on O. jaubertii, Horace Mann published an account of the Hawaiian flora. Mann, who was originally sent to the Hawaiian Islands by Asa Gray to study the flora of the group, spent more than a year travelling throughout the islands collecting plants (Kay 1972). The results of Mann's field work appeared in a lengthy article published in 1866. Mann's incomplete account of the Hawaiian flora included three species of orchids: the two previously described species of Anoectochilus and a new species, Liparis hawaiiensis (Mann 1866). Mann based his new species on a series of three collections from the islands of Kaua'i, O'ahu and Maui. These three collections were grouped under a common number and designated as Mann and Brigham 471.

In addition to describing L. hawaiiensis, Mann also commented briefly on the status of A. sandvicensis and A. jaubertii. Mann regarded the two proposed species as being distinct from each other and included both in his

enumeration of Hawaiian plants. According to Mann A. sandvicensis had a lip with an entire margin, while A. jaubertii had a lip with a fimbriate or dentate margin. Interestingly enough, Mann cited two collections of A. jaubertii in his treatment, but failed to collect what he considered to be representative material of A. sandvicensis. Despite the fact that Mann never collected what he considered to be A. sandvicensis he still maintained the species in his treatment.

Mann's opinion of the status of A. sandvicensis and A. jaubertii was not shared, however, by Heinrich Wawra. Wawra, an Austrian physician and amateur botanist who traveled to Hawai'i during 1872-1873, regarded the two species of Anoectochilus as indistinguishable from each other and combined the two taxa under the older name, A. sandvicensis (Wawra 1875). The author based his decision to combine A. jaubertii with A. sandvicensis on a series of collections he and Mann obtained from the island of Kaua'i. Wawra simply amended Lindley's description of A. sandvicensis to include specimens with flowers with fimbriate or denticulate labella, similar to the material he collected on Kaua'i, and listed the genus in his flora as being monotypic throughout the Hawaiian Islands.

Wawra's treatment of the Hawaiian Anoectochilus was followed a short time later by a discussion of the genus in "Genera Plantarum" (Bentham and Hooker 1880). The two authors mentioned the relationship between A. sandvicensis and A. jaubertii briefly in the third volume of their text. Unlike Wawra, Bentham and Hooker regarded the two proposed taxa as specifically distinct from one another and even went so far as to assign them to different genera. A. jaubertii was included in the genus Odontochilus as recommended by Blume (1858), while A. sandvicensis was transferred to the genus Vrydagzynes Bl. The two species were assigned to different genera by Bentham and Hooker solely on the basis of the toothed as opposed to untooth mesochile of the labellum. Bentham and Hooker regarded Anoectochilus and Odontochilus as having flowers with toothed or appendaged mesochiles, while Vrydagzynes had flowers with non-appendaged mesochiles. Anoectochilus sandvicensis, as originally described by Lindley, had flowers with an unappendaged mesochile and was, therefore, better placed in the genus Vrydagzynes. Anoectochilus jaubertii had a toothed mesochile, but lacked variegated foliage or an elongated spur and was, therefore, moved to Odontochilus.

Bentham and Hooker's treatment of the Goodyera alliance was not a popular one and has not been widely followed by later botanists. The treatment of the alliance established a number of different generic limits and these have not been accepted by many botanists. Several more recent accounts of the alliance all differ substantially from Bentham and Hooker's (Smith 1905; Holttum 1953; Brieger 1974; Seidenfaden 1978). Bentham and Hooker failed to realize the similarity between the two proposed species of Anoectochilus from Hawai'i. This could be explained in part by the fact that neither of them ever saw live material of the two proposed taxa. Interestingly enough, Hillebrand, who had extensive field experience in the Hawaiian Islands, was one of the first to reject Bentham and Hooker's treatment of the Hawaiian representatives of the genus.

Hillebrand, a physician and botanist who resided in the Hawaiian Islands for over 20 years, published his comments on the Hawaiian orchids as part of his "Flora of the Hawaiian Islands" (Hillebrand 1888). The

book, which was based on Hillebrand's extensive field work, included references to 999 species and is still regarded today as the most complete flora ever written for the islands. Hillebrand included three species of orchids in his flora including one new species which he collected on several of the larger islands in the Hawaiian chain. He provided brief descriptions of the genera and species in his flora, notes on the ecology and distribution of each taxon and, perhaps of greatest importance, a brief explanation of why each taxon was assigned to a particular genus or species in his treatment. As a result, Hillebrand's treatment of the Orchidaceae remains not only the most current, published treatment of the endemic orchids in Hawai'i, but is also considered one of the most accurate systematic works on the family in Hawai'i.

Hillebrand chose to follow a treatment similar to the one proposed by Wawra for the genus. Under Hillebrand's treatment of the genus the description of A. sandvicensis was broadened to include plants with flowers with toothed or appendaged unguis of the labella. Anoectochilus jaubertii was reduced to the status of a variety B. Hillebrand's variety B (formerly A. jaubertii) differed from A. sandvicensis var. sandvicensis by having the unguis of the labellum serrulate or fimbriate. Hillebrand also stated that the variety was of questionable validity since "entire and slightly toothed claws are sometimes met within one and the same spike" (Hillebrand 1888). Regarding Bentham and Hooker's decision to move A. sandvicensis to the genus Vrydagzynes, Hillebrand flatly opposed the move. In his discussion of the species Hillebrand stated that Vrydagzynes differed from Anoectochilus by having a short unclawed labellum and a column with two processes projecting into a relatively short spur. It is fairly obvious from this statement that Hillebrand did not correctly assess the difference between the two genera. Vrydagzynes has a labellum with an unappendaged unguis which is not expanded at the apex into a transverse blade. But the labellum also has a relatively long, narrow spur which projects through the ventral sepals and the spur contains two stalked glands. Hillebrand was, however, correct in assuming A. sandvicensis did not belong in the genus Vrydagzynes and his decision not to assign the species to the genus has been supported by more botanists than Bentham and Hooker's treatment of the genus. Concerning Hillebrand's var. B which Bentham and Hooker assigned to Odontochilus, Hillebrand pointed out that the two authors were only following an earlier recommendation by Blume (1858). Hillebrand realized that the Hawaiian representatives of the genus Anoectochilus could also be considered as Odontochilus but he felt that Blume's new genus was of questionable value and should be combined with the genus Anoectochilus.

Hillebrand also commented briefly on Liparis hawaiiensis in his treatment and described an additional species of orchid from the Hawaiian Islands. Habenaria holochila Hillebrand was based on a series of collections the author made during his stay in Hawai'i and on material sent to him by Rev. J. Lydgate and Mr. V. Knudsen. The species was initially reported from the islands of Kaua'i, Moloka'i and Maui. It was found only in boggy locations at fairly high altitudes. Hillebrand did not specify why he assigned his new species to the genus Habenaria nor did he provide any indication of his feelings on the status of Habenaria Willd. as opposed to Platanthera L.C. Richard. His decision in this regard may have been influenced somewhat by Bentham and Hooker's treatment of the genus in "Genera Plantarum". They regarded the genus Habenaria in the broad sense and included both Platanthera L.C. Richard and Peristylus Bl. within the

genus. The status of Habenaria and Platanthera is still contested, however, and it should be noted that Hillebrand's species, H. holochila, was subsequently moved to the genus Platanthera by Kraenzlin (1901) a short time after Hillebrand's death.

Hillebrand's rather lengthy account of the orchidaceous flora of Hawai'i was followed shortly after by a series of three articles which made brief reference to the Hawaiian taxa. The first of these was Otto Kuntze's "Revisio Generum Plantarum" (1891). Kuntze, a German botanist, was primarily interested in the area of botanical nomenclature. His major work, listed above, was nothing more than a series of proposed nomenclatural changes along with an enumeration of the species affected. Liparis hawaiiensis was one of the species affected by Kuntze's treatment. Kuntze discovered that Du Petit-Thouars (1809) had validly published an earlier name for the genus Liparis L.C. Richard (1817). The older name, Leptorchis Thouars (1809), had priority over Liparis and Kuntze proposed that Thouars' name should be adopted. Leptorchis hawaiiensis (Mann) Kuntze (1891) was among the new combinations listed in the text. Heller (1897) adopted Kuntze's new combination a few years later in a rather lengthy article on Hawaiian plants, citing both the basionym and the new combination for the species. The author also included a brief note on the species with a list of additional collections. It should be noted, however, that the name Liparis L.C. Richard was later conserved against Leptorchis Thouars invalidating Kuntze's combination for the Hawaiian species. Heller also listed A. sandvicensis in the same treatment citing both Lindley (1840) and Hillebrand (1888), but did not comment on the species. Conspicuously absent from his treatment, however, is any reference to A. jaubertii. It is difficult to determine if this was merely a simple omission on Heller's part or a reflection of his opinion on the status of the species.

Heller's article on Hawaiian plants was followed by Kraenzlin's (1901) comments on the status of Habenaria holochila. Kraenzlin, who was interested in the Orchidaceae on a worldwide basis, attempted to do what John Lindley had done 60 years earlier: produce a worldwide monograph of the family. His attempt entitled "Orchidaceous Genera and Species" was never completed, but the first volume of the work was eventually published in 1901. Included in the text was a discussion of the relationship between Habenaria, Platanthera and Peristylus. Kraenzlin believed the three genera were distinct from each other and should be retained as separate genera, rather than being combined as sections of the genus Habenaria (*sensu lato*) as suggested by some authors. His treatment affected a large number of species including Hillebrand's Habenaria holochila. Kraenzlin transferred Hillebrand's species to the genus Platanthera and published the new combination, P. holochila (Hillebrand) Kraenzlin (1901). Kraenzlin's decision to split the genus Habenaria (*sensu lato*) into three smaller genera has not been universally accepted, however, and for this reason both names for the species still frequent systematic literature on the subject. A case in point is a treatment published by V. MacCaughy (1916).

MacCaughy's treatment provided a popularized account of the native orchidaceous flora of Hawai'i. The article included a brief, simplified description of each species along with comments on where each occurred. MacCaughy also discussed the derivation of the scientific names and offered some biographical information about the botanists who described

them. The systematic treatment MacCaughey provided was essentially a simplified version of the account Hillebrand published in his flora (1888). None of the nomenclatural changes which followed Hillebrand's account were incorporated in the treatment, nor did MacCaughey provide any indication that he was even aware of these changes. His popular treatment of the group offered little or no new taxonomic information about the endemic species, but did provide the reader with some interesting general comments about Hawaiian orchids. MacCaughey appears to be one of the first to have commented on the notable scarcity of orchids in the Hawaiian flora. He speculated briefly about the cause of this in the article, citing both the difficulties involved in the dispersal of orchids to Hawai'i and a lack of suitable pollinators in the islands as possible reasons. Interestingly enough, recent biological studies of the Hawaiian orchids (Kores unpublished) suggest MacCaughey's tentative conclusions were probably correct.

MacCaughey's rather lengthy popularized account of the Hawaiian orchids was followed by a series of short articles on the subject. The first of these by Skottsberg (1926) was little more than an enumeration of some additional collections of the three endemic species of orchids. Skottsberg also followed Hillebrand in his treatment of the Hawaiian orchids, but, unlike MacCaughey, incorporated a number of recent nomenclatural changes in his account. These changes included listing Habenaria holochila as Platanthera holochila and citing Anoctochilus sandvicensis as Odontochilus sandvicensis. Unfortunately Skottsberg listed the latter combination as O. sandvicensis (Lindl.) Benth. and Hook. f. The combination was not made by Bentham and Hooker, however, nor had it ever been published prior to Skottsberg enumeration. Bentham and Hooker had dealt with the species in "Genera Plantarum," but included it in the genus Vrydagzynes and not Odontochilus as suggested by Skottsberg. As a result Skottsberg inadvertently published a new combination in his treatment but attributed it to the wrong authors. The new combination should be cited as O sandvicensis (Lindl.) Benth. and Hook. f. ex Skottsberg.

Skottsberg's enumeration of Hawaiian plants was followed by articles by Otto Degener which made reference to orchids found throughout the Hawaiian Islands. Degener's first contribution to the literature on the subject appeared as part of a semi-popular book he wrote in 1930. The treatment made brief reference to Liparis hawaiiensis, Habenaria holochila and Vrydagzynes sandvicensis. The third combination was incorrectly cited however, as Degener attributed the name to Lindley, the author of the basionym, and omitted Bentham and Hooker, who actually proposed the change. The combination should have been cited as V. sandvicensis (Lindl.) Benth. and Hook. f. and not as V. sandvicensis Lindl. as it appeared in Degener's book. Degener offered no explanation in his treatment why A. sandvicensis was assigned to the genus Vrydagzynes as originally proposed by Bentham and Hooker, nor has his treatment been followed by later workers. Degener's popular article served to draw attention to the native Hawaiian orchids, but, provided very little new information on the subject. The article is probably best remembered solely for the good illustration of Liparis hawaiiensis which accompanied the text.

A few years after Degener commented on the endemic orchids he published an article dealing with one of the exotic species as part of his "Flora Hawaiiensis" (Degener 1932). The treatment provided a description

of Spathoglottis plicata Bl., an illustration of the species and notes on its establishment on the island of O'ahu. According to Degener the species was originally introduced into Hawai'i from the Philippines as an ornamental. It quickly escaped cultivation and became widespread throughout the island of O'ahu by 1930 (Degener 1932). Degener's reference to the species is the first mention of any naturalized species of orchids occurring throughout the Hawaiian Islands.

Degener's popularized account of the Hawaiian orchids was actually the first in a series of scientific and semi-popular articles on the subject which appeared during the 1930's. Skottsberg (1936) provided some additional information on the distribution of A. sandvicensis as part of an enumeration of recent collections of Hawaiian plants. Only A. sandvicensis was mentioned in the text and no other information about the species was included. Hosaka (1937) produced a similar enumeration of plants collected in Kipapa Gulch, O'ahu, the following year. The listing, which was done in conjunction with an ecological and floristic study of the area included A. sandvicensis, L. hawaiiensis and S. plicata. Hosaka commented on the relative abundance of each of the three species, indicated what type of habitat the species occurred in, and listed the months each species was observed in flower. Marie Neal (1938) also wrote a popular article on the endemic orchids during the same period of time. Her article included a brief description of Odontochilus sandvicensis, Liparis hawaiiensis and Habenaria holochila. Neal did not elaborate on her choice of genera in her treatment. Her article was very similar to Degener's 1930 treatment of the family and provided the reader with about the same amount of information. Neal's publication was followed by another popular article on the cultivated species of orchids in Hawai'i by Krag (1940). Krag did not mention any of the endemic species of orchids in his treatment but did list Arundina graminifolia as one of the species which was extensively grown in Hawai'i. The species has since become naturalized and is widespread on several of the major islands in the Hawaiian chain. Krag's article is interesting in this respect because it seems to be the first reference to mention the species in Hawai'i and dates its introduction into the islands as prior to 1940.

The four articles mentioned above provide the reader with only a meager amount of new information about orchids in Hawai'i. They were followed by a more substantial article on the subject by Fosberg (1943). This article dealt with the nomenclature, taxonomy and distribution of some Pacific islands species of plants and included a description of a new species of orchid from the Hawaiian Islands. Anoectochilus apiculatus L. O. Williams and F. R. Fosberg was described from specimens collected by Fosberg on Moloka'i. The new species supposedly differed from the commoner A. sandvicensis by its smaller, greenish rather than bright yellow flowers; labellum with the spur not conspicuously geminate externally; shorter mesochile with two pairs of subfleshy teeth as opposed to many or no membranous ones; shorter epichile and apiculate rather than acute anther (Fosberg 1943). Fosberg made no reference to any other orchids in his treatment and was either unaware of A. jaubertii Gaud. when he described his new species, or regarded the species as synonymous with A. sandvicensis Lindl. The author did comment though, that his new species was somewhat similar to a plant collected on the island of O'ahu by Morley. He added, however, that Morley's specimen was "unfortunately lost". Precisely how Fosberg performed a comparison between his collection of A.

apiculatus from Moloka'i and Morley's no longer extant specimen from O'ahu is uncertain. Fosberg also cited the generic name for his new species as "Anectochilus". (The name Anoectochilus has been subsequently nomenclaturally and orthographically conserved). Fosberg and Williams' A. apiculatus has been accepted in several more recent articles on the subject. The species is still very poorly collected, however, and is in need of critical reevaluation.

Orchids were mentioned briefly in two publications shortly after Fosberg's note on Pacific plants, though neither of the authors included his new species. The first of these publications (Skottsberg 1942) provided an enumeration of some recent collections of Hawaiian plants including Liparis hawaiiensis, Odontochilus sandvicensis and Platanthera holochila. Skottsberg cited P. holochila as occurring on the island of O'ahu, a new record for the species, which was previously known only from the islands of Kaua'i, Moloka'i and Maui. He also included Spathoglottis plicata in his list, confirming Degener's (1932) and Neal's (1938) report that the species was naturalized on O'ahu. Selling (1947) also mentioned orchids in conjunction with his pollen survey of the Hawaiian Islands. He listed only the endemic species, however, utilizing the same combinations Skottsberg published in his vascular plants series. As expected orchidaceous pollen, which adheres in clumps or pollinia and is not wind dispersed, did not turn up in any of Selling's core samples. But the author did provide a brief description of the pollinia and pollen grains for each of the endemic species. He also included two figures of the pollinia from A. sandvicensis in his text (Selling 1947; Fig. 930, 931).

Skottsberg and Selling's notes on the endemic Hawaiian flora were followed by Marie Neal's extensive book on cultivated plants in Hawai'i. Neal's "In Gardens of Hawaii", published initially in 1948, was the author's major life work and included information on most plants commonly cultivated in Hawai'i. The book was not aimed at the taxonomist trying to unsnarl some aspect of the endemic flora, but was written primarily for the amateur gardener or horticultural enthusiast who had an interest in the islands' ornamental plants. As a result, Neal's treatment of the endemic elements of the flora was often extremely brief, or in the case of endemic groups which lacked showy species, entirely omitted.

Neal's treatment of the orchids in "In Gardens of Hawaii" concentrated primarily upon the commercially important genera being grown throughout Hawai'i. A total of 18 genera were briefly discussed in the text, including Vanda, Cattleya, Epidendrum, Dendrobium and others. Neal provided a key to the horticulturally important genera and listed a few commonly cultivated species for each of the major genera. Needless to say, the endemic species of orchids with their inconspicuous flowers fared very poorly in Neal's treatment. The author included Habenaria holochila, Liparis hawaiiensis, Anoectochilus sandvicensis var. sandvicensis and A. sandvicensis var. jaubertii in her introduction to the Orchidaceae, stating they were endemic to the Hawaiian Islands, but provided no other information about the species. In addition, the three genera which contained the endemic Hawaiian species were not even included in her generic key to the family. Neal provided little or no information on the endemic orchids of Hawai'i, but her treatment was nevertheless valuable for her comments on the exotic representatives of the family in Hawai'i.

Neal's treatment of the Orchidaceae in "In Gardens of Hawaii" was the first publication to include a complete listing of the naturalized species of orchids in the Hawaiian Islands. These included Spathoglottis plicata, which had already been mentioned as being naturalized by Degener (1932), Neal (1938) and Skottsberg (1944); Arundina bambusaefolia Roxb. ex Lindl. (A. graminifolia (Don) Hochr.) mentioned by Krag (1940); Phaius tankervilleae (Banks ex L'Hertier) Bl.; and an undetermined species of Epidendrum. Neal provided an illustration of the species in her text (probably Epidendrum x Obrienianum Rolfe, since the flowers in the figure are obviously nonresupinate), but never attempted to identify the species. Interestingly enough, Neal was apparently the first author to notice that P. tankervilleae and E. x Obrienianum had escaped cultivation and become naturalized on the island of O'ahu. Neal also listed Spathoglottis pacifica Reichb. f. as being sparsely naturalized on O'ahu which was an apparent error. The author was under the impression that S. pacifica had pink to white flowers with the ovary and exterior surface of the sepals densely pubescent, while S. plicata had dark purple more or less glabrous flowers (Neal 1948). This was not correct and has led people to believe a white flowered form of S. plicata occasionally found on the island of O'ahu was S. pacifica. The species, which is endemic to Fiji, has never been collected in the Hawaiian Islands and has not become naturalized, though it may have been cultivated in the state as part of someone's private collection of orchids.

Marie Neal's article was not the last word on Hawaiian orchids. It was followed by a short paper by Degener and Degener (1965). The article was intended to clarify some of the nomenclatural and taxonomic problems surrounding the endemic taxa. The treatment included a detailed account of each of the endemic species along with a discussion of taxonomic treatments which altered the status of the species. Special problems such as orthographic changes or difficulties with typification were also mentioned. The article also posed several very interesting questions concerning the endemic orchids, leveled some strong criticism at past and present treatments of the family in Hawai'i but offered no solutions to the already existent dilemmas mentioned in the text.

Degener and Degener devoted the greatest amount of space in their article to problems associated with the genus Anoectochilus in Hawai'i. The authors felt that the Goodyera alliance, which includes Anoectochilus, was represented in Hawai'i by at least two or possibly more taxa, but they could not decide to which genus the taxa belonged. Degener and Degener tentatively assigned the Hawaiian representatives of the alliance to the genus Odontochilus as suggested by Blume (1858) and might prove that Odontochilus and Anoectochilus were actually the same. They also suggested Vrydagzynes as another alternative, citing Benth and Hooker (1880), but offered no explanation why this genus might be preferable. Degener and Degener listed two species of Odontochilus in their treatment; O. sandvicensis (Lindl.) Benth. and Hook. f. and O. apiculatus (Williams and Fosberg) Degener and Degener. Interestingly enough, the first combination was incorrectly attributed to the wrong authors and was one of four errors in citation Degener and Degener made in the text. The citation should have appeared as O. sandvicensis (Lindl.) Benth. and Hook. f. ex Skottsberg. The second combination was new and has been correctly attributed to Degener and Degener.

Degener and Degener also mentioned A. jaubertii in their discussion but attributed the species to the wrong author. The two combinations published by Degener and Degener, A. jaubertii (Bl.) Gaud. and O. jaubertii Bl. were both incorrectly cited. The species should have been attributed to Gaudichaud and not Blume. The correct citations for the combinations are A. jaubertii Gaud. (1843) and O. jaubertii (Gaud.) Bl. (1858). Degener and Degener admitted that Gaudichaud published a figure of A. jaubertii in his atlas to the "Voyage autour du monde . . . sur la corvette la Bonite" in 1843, but they did not accept the species as being validly published until an explanation of the figure appeared in 1866 (d'Alleizette). Since this date was later than Blume's treatment of the species in his "Flora Java Nova Series" published in 1858, Degener and Degener regarded Blume as the legitimate author of the species; hence the two incorrect citations listed above. It should be noted, however, that Degener and Degener's conclusions about A. jaubertii were contrary to the rules of the International Code of Botanical Nomenclature. Article 44 of the code states that the name of a species published before 1 January 1908 is validly published if it is accompanied only by an illustration showing essential characters. Under Article 44 of the code, A. jaubertii was validly published in 1843 when the plate appeared and not 1866 as suggested by Degener and Degener. This date predates Blume's treatment of the species and the combination A. jaubertii therefore has priority over the ones proposed by Blume.

Degener and Degener regarded A. jaubertii as equivalent to Hillebrand's A. sandvicensis var. B (Hillebrand 1888) in their article but they also pointed out the possibility that the taxon might represent a number of potentially new taxa from Hawai'i. The two authors did not go on to describe any additional taxa however. Also included in the article was one additional incorrect citation. Degener and Degener listed Vrydagzynes sandvicensis Benth. and Hook. f. omitting Lindley, who was the original author of the species. The citation should have appeared as V. sandvicensis (Lindl.) Benth. and Hook. f.

Degener and Degener treated the remainder of the endemic Hawaiian orchids much more conventionally. The two authors regarded L. hawaiiensis as a Liparis which was no surprise since there have never been any major taxonomic or nomenclatural problems associated with the species. There were some minor problems concerning the typification of the species, however, and Degener and Degener were quick to point these out. According to Degener and Degener, Mann never specified where he collected the type of L. hawaiiensis which he designated as Mann and Brigham number 471. The two authors went on to suggest that the material came from the island of Hawai'i which was only partially correct. The annotation in Mann's field book under number 471 states the material originated from the mountains of West Maui above Kamalalaea Bay, but the phrase is followed by a note stating that the material was the same as a collection made on the island of Hawai'i near Hilo and on the island of Kaua'i near Waimea. It is clear from this note that Mann regarded all three collections as conspecific. Nevertheless, Degener and Degener used the fact that the species was typified by what amounted to a series of syntypes as an excuse to suggest that additional taxa might be present throughout the Hawaiian Islands.

The third endemic species of orchid in Hawai'i, Platanthera holochila (Hillebrand) Kraenzlin was also mentioned by Degener and Degener, but the

species was apparently so poorly known even by Degener and Degener, that it was only briefly mentioned in their treatment. Degener and Degener listed both Platanthera holochila and Habenaria holochila, but did not state which genus was preferable for the species. In addition, the two authors commented that the species was extremely rare throughout the state and indicated that there was probably only the single species of the genus represented in the Hawaiian Islands.

Degener and Degener (1965) was the last major article dealing exclusively with the endemic and naturalized orchids in Hawai'i, but the family was also mentioned briefly in a number of more recent publications dealing with Hawaiian plants. Fosberg (1969) made reference to Degener and Degener's article on orchids (Degener and Degener, 1965) and included notes on two of the species found in Hawai'i: Arundina graminifolia (Don) Hochr. and Odontochilus sandvicensis (Lindl.) Benth. and Hook. f. Fosberg apparently followed the previous authors in citing the last combination and like his predecessors incorrectly attributed to the authors. His mistake was shared by Skottsberg (1926, 1936, 1944) and Degener and Degener (1965). The combination was first published by Skottsberg (1926) and should be attributed to him and not Benth and Hooker as it appears above.

Fosberg's comments on Arundina graminifolia dealt exclusively with some nomenclatural problems associated with the species. The author pointed out that the species was generally known throughout Hawai'i as A. bambusifolia Lindl. which was incorrect. According to Fosberg, Lindley's name for the species was based on a name proposed by Roxburg in 1814, but Roxburg did not describe the species in 1814. As a result, his name Bletia graminifolia Don (1825) which was conspecific with Roxburg and Lindley's species. Hochreutiner (1910), later transferred the species to the genus Arundina. Since D. Don's basionym for the epithet clearly has priority over Lindley's, the correct name for the species is A. graminifolia (Don) Hochr., not A. bambusifolia. Fosberg was not the first to notice that A. graminifolia was often incorrectly named, his conclusions about the species were shared by Holttum (1953) and Backer and Bakhuizen van den Brink (1968). Unfortunately his note about the species in the Hawaiian literature has gone largely unnoticed and the species is still commonly, incorrectly referred to as A. bambusifolia.

Fosberg (1969) also mentioned Odontochilus sandvicensis in his treatment, but his reason for doing so was primarily to correct a number of popular misconceptions about the species perpetrated by Degener and Degener. The two authors implied in their 1965 article that the species was quite rare on the island of O'ahu and was confined to the summit of Mt. Ka'ala. Fosberg pointed out that the species had also been collected in the Ko'olau mountains of O'ahu on a number of occasions and had been quite common along the main ridge at one time. According to Fosberg, the Ko'olau mountains above Sacred Falls were also the source of the now legendary Morley specimen of Anoetochilus with green flowers. This material was supposedly specifically distinct from previous collections of Anoetochilus from the island of O'ahu. Fosberg suggested that the specimen may have been conspecific with his A. apiculatus which was, at that time, yet to be described. Regrettably, Morley's only collection of the new Anoetochilus was absolutely and irrevocably destroyed and the original population of the plant from which Morley obtained his specimen was never relocated (Fosberg 1969). As a result the taxonomic affinities of Morley's material still remain uncertain.

Fosberg's note on Hawaiian plants (1969) was one of the last articles to mention endemic or naturalized orchids in Hawai'i in any detail. The publication was followed by two enumerations of Hawaiian plants which included orchids and a very brief popular article. The first of these, St. John (1973), listed four endemic species of orchids and no infraspecific taxa as occurring in Hawai'i. Included in St. John's list were Anoectochilus apiculatus, Anoectochilus sandvicensis (including Gaudichaud's Anoectochilus jaubertii), Liparis hawaiiensis and Platanthera holochila. St. John also provided a list of synonyms for each species, but did not explain his choice of genera. The same four species mentioned by St. John later found their way into an enumeration of rare and endangered plants in Hawai'i published by Fosberg and Herbst (1975). The article included a list of all taxa thought to be endangered in Hawai'i along with an indication of their present status in terms of relative abundance. This last point was really a reflection of the authors' opinion and ranged from locally common to extinct. Since all of the endemic orchids were relatively rare, they were included in the list. The species were ranked as follows: Anoectochilus apiculatus, very localized and rare; Anoectochilus sandvicensis, rare but of uncertain status; Liparis hawaiiensis, depleted but populations apparently stable, and Habenaria holochila, rare or possibly endangered but of uncertain status. Interestingly enough, Fosberg and Herbst reported H. holochila as possibly endangered even though the plant has not been seen alive since 1938 and was considered extinct by many botanists. Caution was well founded, however, as the species turned up in the Alakai swamp on the island of Kaua'i in 1977. This rather remarkable find was the subject of an article by Perlman (1978). The note reported the find and included a photograph of this extremely rare Hawaiian orchid. It was also the last reference to mention the orchidaceous flora of the Hawaiian Islands.

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Minutes: December 4, 1978 Meeting

The meeting was called to order by President Obata promptly at 7:30 p.m. The secretary presented the annual report for the year 1978. This was followed by the treasurer's report. The treasurer reported that the society collected \$305.50 in dues for the year and that this was a critical area in the society's budget.

It was announced that Dr. Thomas Croat would be giving a lecture on "The aroids of Central America" for the Pacific Tropical Botanical Garden and members were invited.

The Audubon Society announced that it would hold its December meeting at the Moiliili-McCully library and invited all members to attend.

The slate of officers for 1979 were presented to the members. They are as follows:

President - Keith Woolliams
Vice-president - Nadarajah Balakrishnan
Secretary - Winona Char
Board of Directors - Gerald Carr and John Obata

The nomination was moved and seconded.

The new president then assumed his duties and praised the excellent job done by the out going president.

It was announced that Dr. David Chruchill from the Royal Botanic Gardens in Melbourne, Australia would be giving a series of lectures in conjunction with the Cook Bicentennial in December.

The out going vice-president then introduced the speaker for the evening, Mr. Fred Trotter, who spoke on "The Waianae Mountains, access and preservation from management's point of view."

Respectfully submitted,
Winona P. Char, Secretary

Minutes: January 8, 1979 Meeting

The first meeting of the year was called to order by President Woolliams at 7:30 p.m. This meeting marks the 55th year for the society.

The new slate of officers for the year were introduced to society members. Members of several committees were also announced. They are as follows:

Refreshment Committee: June Saito, Jeannie Young, Phil Burton

Membership Committee: N. Balakrishnan, Mark Towata, Gordon Daida

Native Plant Species Committee: Dr. Dan Palmer, Dr. Deral Herbst, Dr. Gerald Carr, Dr. Charles Lamoureux, John Obata, and a new member, Dr. Carolyn Corn

Conservation Committee: John Obata, other members are needed

Door Prizes Committee: Ted Green

Plant Exchange Committee: Ray Baker (Plant exchange will be held on the following months: March, June, Oct., Dec.)

Dr. Palmer, chairman of the Native Plant Species Committee, announced that they have been very active in gathering data and setting up criteria for rare and endangered plants.

A dues increase at this time is felt to be necessary by the executive committee. The fees are set up in our constitution and therefore it is necessary to amend Article VII, Section 2. A vote to change the membership fees and amend the constitution will be taken up in the February meeting.

To solve part of our financial problems three things must be done:

1. increase dues,
2. drop non-paying members from the society, and
3. have a membership drive to increase our list of paying members.

All records of the society are deposited in Sinclair Library, 3rd floor, University Archives section if any members are interested.

Copies of the society's 50th anniversary booklet, which contain the Constitution, are available from the secretary. The Index to the Newsletter is also available for \$1.00 from the secretary.

The society is urged to support the Native Plant Species Committee and also to consider supporting work done on some of the non-flowering plants such as mosses, ferns, algae, and fungi.

The president reported that he had spoken to Charles Yasuda, of the Dept. of Agriculture, about control of Clidemia hirta (Koster's curse) and that Mr. Yasuda had replied that progress was being made in this area.

The Audubon Society announced that they would be holding their meeting at the Moiliili-McCully Library on January 22.

Dr. Lamoureux announced that Dr. A. C. Smith's Flora Vitiensis Nova, Vol. I was about to be released by the Pacific Tropical Botanical Garden.

The vice-president then announced the "Plant-of-the-month" speaker, Dr. Gerald Carr, who spoke about the genus Dubautia, an endemic Compositae, he is presently studying. The speaker for the evening was then presented--Dr. Charles Lamoureux, who spoke on "Why are there so many endangered species in Hawaii?"

Respectfully submitted,
Winona P. Char, Secretary

Minutes: February 5, 1979 Meeting

The meeting was called to order at 7:35 p.m. by President Keith Woolliams.

President Woolliams announced that Pacific Tropical Botanical Garden will once again provide the prizes for the two Science Fair winners.

The motion to amend the dues for members was carried during this meeting. This affects Article VII, section 2. The new dues are: \$4.00 for students of institutions of higher learning; \$7.50 for regular members; \$10.00 for families. It was recommended that we should also consider removing the section setting up membership dues amount from the by-laws later on.

March is plant donation month and plants donated should be in good condition and not greenhouse discards.

Dr. Dan Palmer was officially appointed auditor for the society.

A short demonstration on the use and preparation of coconut in Ceylonese cooking was presented.

After this the vice-president announced the speaker for the evening. Dr. C. E. Jones, Professor of Botany at California State University, Fullerton, gave a lecture on "Pollination in plants."

Respectfully submitted,
Winona P. Char, Secretary

Minutes: March 5, 1979 Meeting

The meeting was called to order at 7:30 p.m. by President Woolliams.

The Pacific Tropical Botanical Garden has presented the society with two copies of J. F. Rock's "Indigenous Trees of the Hawaiian Islands"; these will be awarded to the two Science Fair winners picked by the society.

The president presented a request by Steve Montgomery that the society approach the trustees of the Marie Neal fund for \$100.00 to be used in providing a poster for National Wildlife Week. The poster would bring National Wildlife Week down to the state level since it would feature native plants--Vicia menziesii, the Hawaiian vetch, and Acacia koa. It was moved and approved by the society that such funds should be requested from the trustees.

President Woolliams also brought up the present situation and status of Vicia menziesii. The native vetch is threatened with extinction due to the re-forestation practices by the Bishop Estate and by hapu'u harvesting. A fact sheet about Vicia menziesii can be obtained from the president.

The secretary, substituting for the vice-president, then announced the "Plant-of-the-month" speaker, Eileen Makuchan, a graduate student in Botany, who spoke on the native 'ape'ape (Gunnera).

After this the speaker for the evening was presented. Mark Merlin, with the General Science Department at the University, talked about the "Natural origins and early cultural history of the opium poppy."

Respectfully submitted,
Winona P. Char, Secretary

Minutes: April 2, 1979 Meeting

The meeting was called to order at 7:35 p.m. by President Woolliams. Under old business the president informed members of the society that the request for \$100.00 from the Marie Neal Fund to be used for the National Wildlife Hawaii poster needs only one more trustee's signature to be approved.

Keith Woolliams and Dan Palmer, chairman of the Endangered Species Committee, met with Mr. Cunha, a trustee of the Bishop Estate, in reference to the Vicia menziesii problem. A letter followed requesting that the Bishop Estate activate their research committee, and to turn the 50 acres containing the Vicia into a reserve. A letter of acknowledgement was sent to the society by Mr. Rosehill. The Garden Club of America has written to the president of the society and is very interested in the Vicia controversy.

President Woolliams announced that all society members should actively engage in seeking new members for the society. A number of ideas on where to recruit new members were discussed.

The Pacific Tropical Botanical Garden has donated two copies of Rock's Indigenous Trees of the Hawaiian Islands for the Science Fair. The Fair opens this week and judges are needed.

The "Plant-of-the-month" speaker, John Obata, then spoke on Bonamia menziesii, an endemic species in the Morning-glory family (Convolvulaceae). The speaker for the evening was then introduced--Mr. Richard Carpenter who spoke on "Environmental assessment and economic development."

Respectfully submitted,
Winona P. Char, Secretary

RECENTLY COMPLETED THESES
IN BOTANICAL SCIENCES
AT
THE UNIVERSITY OF HAWAII'I

MASSEY, Jane E. 1978. Lake Waiau: A Study of a Tropical Alpine Lake, Past and Present.

The influence of an array of physical and chemical factors on diatom populations and phytoplankton productivity in Lake Waiau, Hawaii, was studied. Lake Waiau, a shallow, heart-shaped water body about 0.6 ha in area at the time of study, is located at 3969 m on the summit plateau of Mauna Kea, island of Hawaii. From a study of ancient and contemporary lake sediments, 13 diatom species were identified, one, a new species. Diatom species found at Lake Waiau were typically smaller and more highly silicified than their counterparts in other localities. The paucity of species in the lake is attributed mainly to extreme isolation. In the older sediments, a plot of the number of individuals of each of two *Nitzschia* species as a function of core depth revealed possible biogeochemical relationships. Indications of biological competition and human influences were also disclosed. The contemporary ecosystem was examined in terms of a complex of physical and chemical factors believed to be influencing the limited rate of production of Lake Waiau. In spite of its status as a highly productive alpine lake (350 mg C/sq m/day at period of observed maximum), the photosynthetic capacity was found to be limited. High levels of nickel, found to be negatively correlated with the rate of production, suggest possible heavy metal toxicity. Sulfate concentrations which were low in comparison with other alpine and arctic lakes, also may limit productivity. In situ experiments proved inconclusive, however sulfate was found to be negatively correlated with the production rate on multiple regression analysis. A complex of physical and chemical factors was found to be influencing the rate of production at Lake Waiau. No one factor was found to be the 'limiting factor'. A variety of environmental and nutritional factors influence the rate of primary production at Lake Waiau. Changes in the morphometry and chemistry of Lake Waiau were found by comparing current and earlier data spanning a nine year period. Such changes are typical of small, shallow bodies of water such as Lake Waiau. Management proposals have been made for the protection of this unique resource.

NEWSLETTER
HAWAIIAN BOTANICAL SOCIETY
c/o BOTANY DEPARTMENT
UNIVERSITY OF HAWAII
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THE NATIVE COASTAL PLANTS OF O'AHU, HAWAII

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INTRODUCTION

The most vulnerable elements in the coastline vegetation are the endemic strand elements, which are narrow in range ... and the endemic elements of the native dry forests, which may have extended to the coast in the leeward areas.... (Richmond & Mueller-Dombois 1972).

The demise of the Hawaiian endemic flora has been a concern for many decades. Degener (1932 et seq.), Egler (1947), and Richmond and Mueller-Dombois (1972) have documented the gradual loss of native plants on O'ahu due to the impacts of agriculture, development, and introduced plants. In recent years, with increased interest in Hawaiiana, the native Hawaiian environment, and coastal zone management, there has been increasing concern for native coastal plants. This is shown by several recent publications written for general audiences on this subject: Arrigoni (1977, 1978), Merlin (1977), and Tabata (1979). Also, a 20-minute slide/tape program "Na Mea Ulu Ma Kahakai o Hawai'i" was produced by Kimura and Nagata (1979).

For O'ahu, particularly, there is now new information on the status of native coastal plants: Richmond and Mueller-Dombois (1972) on O'ahu coastline ecosystems; Fosberg and Herbst (1975) on rare and endangered plants; Herbst (1976), EIS Corp. (1977), and Miura and Sato (1978) on the Barber's Point Deep-Draft Harbor site; Stemmermann (1977) on Hawaiian sandalwoods (*Santalum* spp.); Degener and Degener (1978) on the 'ohai (*Sesbania* spp.); Elliott and Hall (1978) on the Kahuku area; Char and Balakrishnan (1979) on the 'Ewa Plains flora; Gardner (1979) on nehe (*Lipochaeta* spp.); and Kimura and Nagata (1980) on endangered coastal environments. These works provide considerable new information on the taxonomy and distribution of O'ahu's native coastal flora, particularly those considered threatened or endangered.

OBJECTIVES

The objectives of this paper are: (1) to generally describe coastal environments associated with native coastal plants; (2) to survey the status of O'ahu's native coastal flora, especially the threatened and endangered plants; (3) to provide examples of management concerns; and (4) to offer recommendations for consideration. A bibliography of pertinent literature is provided. A plant checklist originally prepared for publication in the proceedings is appended.

VALUES OF NATIVE COASTAL PLANTS

The study of Hawai'i's native coastal flora is important to science as it would help to improve our understanding of the Hawaiian environment and would show us how native plants adapt to varying conditions at the shoreline, including exposure to heat, intense sunlight, drought,

salt spray, blowing sand, and onshore winds. The study of native plants may also benefit man; medicinal uses and genetic characteristics having economic value (e.g., resistance to disease) are associated with certain native plants. The study of the native coastal flora is also important for educational purposes. Areas such as Ka'ena and Kaloko ("Alan Davis Beach" or "Queen's Beach") provide many opportunities for field trips and studies for students as well adults. On such occasions, studies dealing with other subjects relating to the coastline can easily be integrated into the curriculum: climatology, geology, marine algology, nearshore oceanography, social studies, the study of tidepools, and Hawaiiana. Some coastal plants such as naupaka-kahakai (Scaevola taccada (Gaertn.) Roxb.) and 'aki'aki (Sporobolus virginicus (L.) Kunth) are not only a part of the beach landscape, but also provide some protection against storm waves by helping to bind sand dunes. As sea level appears to be rising slowly at 5.6 inches per century, dune systems may be particularly important for protecting inland areas.

There is also some recent interest in using native coastal plants such as hinahina-ku-kahakai (Heliotropium anomalum H. & A.) and 'ohai for ornamental and lei-making purposes. As for economic value, some coastal plants such as the alula (Brighamia citrina var. napaliensis St. John, a lobelia relative from Na Pali, Kaua'i) are being cultivated and sold commercially as house plants. Other native coastal plants, notably the naupaka-kahakai, provide a setting for beach recreation. Commonly seen on many windward coasts with sand dunes are scores of picnickers, campers, and sunbathers among the clumps of naupaka (Scaevola).

There are many recreators who value such areas for joy-riding and "dune-busting." However, off-road recreational vehicle (ORV) use is often detrimental to coastline environments, particularly naupaka on sand dunes. At places like Ka'ena, Kahuku, and Kaloko, ORVs (e.g., motorbikes, dune buggies, and jeeps) are commonly driven on the sand dunes and nearby areas.

COASTAL ENVIRONMENTS ON O'AHU

This paper is limited to the strand and dry coastal lowland flora of O'ahu and their associated environments. Coastal wetlands and areas along embayments (e.g., Pearl Harbor and Kane'ohe Bay) were specifically not considered. The dominant flora generally associated with the latter types of areas include: hau (Hibiscus tiliaceus L.), mangrove (Rhizophora), and bulrush (Scirpus).

A few native plants occasionally encountered in isolated wet areas within the strand or dry coastal lowlands were considered for field trip reference purposes: the water hyssop, Bacopa monniera (L.) Wettst.--Ka'a'awa Beach; the marsh cypress, Cyperus javanicus Houtt.--Mokule'ia, near Camp Erdman; and Marsilea villosa Kaulf., an endemic fern--Koko Head.

Strand Environment

Strand plants directly influenced by the sea are the primary focus of this paper. The harsh strand environment is characterized by salt spray, constant wind, low rainfall, intense sunlight, high evaporation, high

temperatures, and shifting sands. Strand plants have a variety of special adaptations to cope with these conditions, including small, succulent, often hairy leaves; succulent stems; prostrate habit; thick cuticles; and rosette leaves. The vegetation zone influenced by the ocean varies in width. On windward coasts unprotected from waves and salt spray (e.g., Ka'ena), the strand vegetation may extend far inland. On the other hand, along sheltered embayments (e.g., Kane'ohe), there may be little or no strand vegetation (AECOS 1979).

Richmond and Mueller-Dombois (1972), in attempting to relate vegetation patterns to environmental factors (i.e., climate, physiography, exposure to wind and spray, substratum, and ground water), recognized 13 ecosystem classes, of which four could be considered strand-related environments:

- * Scaevola on dunes (e.g., Paumalu, Kahuku, Makapu'u, Ka'ena, and Mokule'ia);
- * Scaevola on raised reef (Hau'ula);
- * Scaevola on rocky basalt (Kaloko);
- * Scaevola on talus and alluvium (Camp Erdman).

Five other ecosystem classes, principally associated with leeward O'ahu shores, had relatively narrow strand vegetation zones due primarily to the invasion of introduced lowland plants such as swollen fingergrass (Chloris), koa-haole (Leucaena), and kiawe (Prosopis):

- * Chloris-Sida (swollen fingergrass-'ilima) on talus (e.g., south of Ka'ena);
- * Chloris-Prosopis on dune and clay flat (Barber's Point);
- * Prosopis on talus and alluvium (Kahe, Ma'ili);
- * Prosopis on tuffaceous headland (Palea Point);
- * Prosopis on dunes (Nanakuli, 'Ohikilolo).

The distribution of strand vegetation on O'ahu, then, appears to be largely affected by exposure to wind and salt spray. One recent report (AECOS 1979) observed that most strand plants are found in the maritime zone not because they need salt or some other characteristic but because they are better adapted to compete with faster-growing lowland plants. A useful guide to classifying terrestrial environments, especially near the sea, is provided in the AECOS report. The guide helps classify strand/ lowland vegetation at or near sea level on the basis of: (1) degree of wind and salt spray exposure evidenced by the proximity of trees to the seaward vegetation line; and (2) substratum types, ranging from basalt rock to dunes. This classification scheme would be useful for identifying sensitive habitat types for management purposes.

Coastal Lowland Environments

For the purposes of this paper, dry lowland flora found in coastal areas were included. Many native lowland flora can be found today at Ka'ena, Makapu'u, Koko Head, Diamond Head, and Kalaeloa (Barber's Point). Some are found fairly close to the sea and are easily accessible from the coast (e.g., naio or Myoporum sandwicense Gray, at Kaloko). Others described in this paper are perhaps marginal coastal plants as they are found at the edge of the transitional zone between the strand and dry forest vegetation, often on talus slopes, cliffs, and ledges near the sea (Kimura & Nagata 1980). Nevertheless, they are also exposed to some of the conditions faced by strand plants, though perhaps to a lesser degree. For the dedicated, intrepid hiker, these transitional coastal plants are also accessible from the coast.

Climatically, the coastal lowland flora described in this paper are mostly in the "summer drought" zone adapted by Char and Balakrishnan (1979) from Kartawinata and Mueller-Dombois (1972) and from Richmond and Mueller-Dombois (1972). Figure 1 illustrates the location of the three major climatic zones of O'ahu and major coastal sites having significant native coastal flora.

In terms of typical vegetation, several habitat types described by Fosberg (1961) are associated with coastal lowland flora:

- * Kakonakona-'ilima seasonally dry scrub-grassland
drier areas on coastal flats or lower slopes, mostly leeward; typical plants include wiliwili (Erythrina), ma'o (Gossypium), nehe (Lipochaeta), kakonakona (Panicum torridum Gaud.), and 'ilima;
- * Pili grassland
coastal flats and foothills in drier parts of O'ahu; typical plants include pili (Heteropogon contortus (L.) Beauv. ex R. & S.) and a variety of introduced plants (e.g., kolu (Acacia farnesiana (L.) Willd.), lantana (Lantana camara L.), koa-haole, prickly pear (Opuntia) kiawe, and Christmas berry (Schinus terebinthifolius Raddi));
- * Eragrostis variabilis grassland
from coral sand on beaches to moderately wet forest, and lower drier sites of main islands; typical plants include variable lovegrass or 'emo-loa (Eragrostis variabilis (Gaud.) Hbd), sedge (Fimbristylis), and nehe (Lipochaeta integrifolia (Nutt.) Gray).

Representative coastal areas on O'ahu with these types of habitats include the Koko Head to Makapu'u area, Diamond Head, and the Ka'ena to Mokule'ia area.

THE NATIVE COASTAL FLORA OF O'AHU

It is truly difficult to reconstruct the native flora which once pervaded the dry coastal areas of O'ahu. Accounts are generally

sketchy and collection data are not always adequate. However, from the few available accounts--notably, Hillebrand (1888), Rock (1913), MacCaughy (1918), Degener (1932 et seq.), and Egler (1947)--a general picture can be drawn of the typical flora of the strand and coastal lowlands. In addition, for specific plant groups, monographs and other papers provide some insight regarding the distribution of coastal plants on O'ahu: Rock (1916), Skottsberg (1927), and Stemmermann (1977) on sandalwoods (Santalum spp.); Sherff (1935) and Gardner (1979) on nehe (Lipochaeta spp.); Sherff (1936) on 'akoko (Euphorbia spp.); and Degener and Degener (1978) on the 'ohai (Sesbania spp.).

An interesting account of the former native vegetation of the coralline 'Ewa Plains is presented by Char and Balakrishnan (1979: 59-60). It is difficult to imagine that plants which are rare today, especially many lowland plants, once stood where kiawe and other introduced plants now predominate. It is quite apparent that what remains today of native coastal plants is a mere remnant.

Indigenous Coastal Plants

Among the native coastal flora, a number are indigenous and relatively common in certain localities. Familiar members of the indigenous strand flora include:

Alena (Boerhavia diffusa L.)

(Indig. Tropics)

Fimbristylis pycnocephala Hbd.

(Indig. H.I. to Solomon Is., Laysan I.)

a coastal sedge;

Hinahina-ku-kahakai (Heliotropium anomalum)

(Indig. Pacific Is.)

Nena (Heliotropium curassavicum L.)

(Indig. H.I., America)

Pohuehue (Ipomoea brasiliensis (L.) Sweet)

(Indig. Pantropic)

also called beach morning glory;

'Ohelo-kai (Lycium sandwicense Gray)

(Indig. H.I., Polynesia)

'Thi (Portulaca lutea Soland. ex Forst f.)

(Indig. H.I., Pacific Is.)

Naupaka-kahakai (Scaevola taccada

var. sericea (Vahl) St. John)

(Indig. H.I., tropical Pacific and Indian Oceans)

..kulikuli (Sesuvium portulacastrum (L.) L.)

(Indig. Tropics)

'Ilima (Sida fallax Walp.)

(Indig. H.I., Pacific Is., China)

'Aki'aki (Sporobolus virginicus)
(Indig. Pantropic)

Nohu (Tribulus cistoides L.)
(Indig. trop. cosmop.)

Nanea (Vigna marina (Burm.) Merr.)
(Indig. H.I., Tropics)
also called beach pea;

Pohinahina (Vitex ovata Thunb.)
(Indig. H.I., Asia, Pacific Is.)

Some of these indigenous plants are locally uncommon due to pressures from intense recreational activity. For example, many dune systems with naupaka-kahakai and pohuehue have been heavily damaged or obliterated by coastal development, trampling, and vehicular traffic.

Endemic Coastal Plants

Many of the Hawaiian endemic coastal plants found on O'ahu are relatively abundant. The endemic strand representatives include:

- * Kauna'oa (Cuscuta sandwichiana Choisy)
(End. H.I.)
an orange vine-like parasite in the morning-glory family; locally common in areas such as Ka'ena and Kaloko;
- * 'Akoko (Euphorbia degeneri Sherff)
(End. Kaua'i, O'ahu, Moloka'i, Maui, Hawai'i)
a typical strand plant found on arid sand dunes, rocky or clay soils, near the sea; it has been reported from Kailua and Waimanalo, as well as many other locales on O'ahu (Hillebrand 1888; Degener 1932 et seq.);
- * Pa'u o Hi'iaka (Jacquemontia sandwicensis Gray)
(End. H.I.)
another member of the morning-glory family, with pale white to blue, bell-shaped flowers; commonly found on dry plains and rocky slopes, especially near the sea;
- * Hawaiian nama (Nama sandwicensis Gray)
(End. H.I.)
a perennial herb with bluish flowers, found chiefly on coastal dunes and sandy areas; once reported from Kahuku and Waikiki (Hillebrand 1888), it is quite common seasonally at Kaloko;
- * 'Ihi (Portulaca cyanosperma Egler)
(End. Kaua'i, Lehua, O'ahu, Hawai'i)
a reddish prostrate herb fairly common on Koko Head, especially on the slopes around Hanauma Bay.

Other endemic coastal plants, more common on coastal plains and slopes, include:

Naio (Myoporum sandwicense)

(End. Kaua'i, Ni'ihau, O'ahu, Moloka'i, Lana'i, Maui)
partial to leeward areas in shallow or rocky soils; it grows as a shrub near sea level and as a tree at higher elevations;

Kakonakona (Panicum torridum)

(End. O'ahu to Hawai'i, and Leeward Is.)
an annual panicgrass quite common in areas such as Ka'ena and Koko Head;

Kupala (Sicyos microcarpus Mann)

(End. O'ahu, Kaua'i)
locally common vine member of the gourd family found during rainy seasons at places such as Kalaeloa, Ka'ena, and Kea'au.

Threatened and Endangered Coastal Plants

A number of coastal plants found on O'ahu are candidates for threatened or endangered species designation. The following summarizes their current status.

Marsilea villosa is a small fern endemic to the Hawaiian Islands. Each leaf has four leaflets (like a four-leaf clover). Marsilea can be found growing carpet-like in wet depressions subject to occasional drying. Forbes observed that it was becoming rare around 1920. Between 1925 and 1933, Marsilea was observed at Nanakuli, Makapu'u, and Lualualei (Degener 1932 et seq.). Marsilea has also been reported from Mokapu Peninsula and Diamond Head crater (Corn, pers. comm. 1980). A population was photographed at Barber's Point beneath kiawe in 1932 (Char & Balakrishnan 1979) but has not been seen there lately. A fairly large population is still found in 'Ihi'ihilauakea, a depression on Koko Head.

Pololei (Ophioglossum concinnum Brack.) is a single-bladed fern endemic to O'ahu, Moloka'i, Lana'i, Maui, and Hawai'i. It was last collected on O'ahu at Sisal, a town near 'Ewa, by Forbes and Cooke in 1912.

Eragrostis paupera Jedw. is an annual grass endemic to O'ahu and related to E. variabilis, the more common variable lovegrass. Like the pololei, it was last seen on O'ahu at Barber's Point, 'Ewa, by Egler and Olivier in 1937. Fosberg and Herbst (1975) think this species is probably extinct.

Panicum carteri Hosaka, an annual panicgrass endemic to O'ahu, was thought to be extinct (Fosberg & Herbst 1975) but has been reported recently from Mokoli'i (Chinaman's Hat); it is being nominated for endangered status. A relative, Faurie's panicgrass (P. fauriei Hitch.), is endemic to O'ahu, Moloka'i, and Lana'i; this species has been reported from Koko Head and Popoia Island. Species reported from Koko Head as P. fauriei by Fosberg (1961) is probably P. nubigenum Kunth, a more common species reported from O'ahu, Moloka'i, Lana'i, and Hawai'i (Herbst, pers. comm. 1980).

Achyranthes splendens var. rotundata Hbd. (Amaranthaceae) is considered by many botanists to be truly endangered. Endemic to O'ahu, it has been reported from Wai'anae and Ka'ena (Hillebrand 1888) as well as from Barber's Point (Herbst 1976; EIS Corp. 1977; Char & Balakrishnan 1979). It is a bushy shrub two to four feet tall with broadly rounded, thick silvery leaves; flower spikes are six to 12 inches long. A few individuals have been seen on the talus slopes of Ka'ena; however, today, the main population is limited to the Barber's Point area.

Another genus in the Amaranth family, Nototrichium, is represented in the coastal flora of O'ahu by four endemic taxa. These may be considered marginal coastal plants as they are associated more with lower elevation vegetation such as on the tops of talus slopes; they are at the fringe of the coastal zone. Kulu'i or Kaala nototrichium (Nototrichium humile Hbd. var. humile) was collected by Hillebrand at Ka'ena (Degener 1932 et seq.) and noted by Rock (1913); it was not reported in a recent survey of Ka'ena (Hawaii, Division of State Parks 1978). Nototrichium humile var. subrhomboideum Sherff was noted on the windward talus slopes in the coastal zone. Nototrichium viride var. subtruncatum Sherff, collected in 1950 from sea level to 1200 feet between Mokule'ia and Kawaihapai (Degener 1932 et seq.), has not been seen lately. Finally, kulu'i or Hawaiian nototrichium (N. sandwichense (Gray in Mann) Hbd. var. sandwichense) has been observed on the talus slopes of Manini Gulch at Ka'ena; it is endemic to Kaua'i, O'ahu, Moloka'i, Lana'i, Maui, and Hawai'i.

Maiapilo (Capparis sandwichiana DC. var. sandwichiana) is endemic to the north shores of O'ahu between Ka'ena and Makapu'u. Its white flowers are nocturnal and fragrant. Although rare, it has been observed at Ka'ena Point, and on Popoia and Kekepa islands off windward O'ahu. It may also have been observed at Hau'ula 50 to 70 m (164-230 ft) inland (Richmond & Mueller-Dombois 1972). Another variety, zoharyi Deg. & Deg., is not considered rare or endangered but is thought to be depleted (Fosberg & Herbst 1975). It is found on Midway and other main islands, such as at Keahole Point, Hawai'i; on O'ahu, var. zoharyi is found today only at Barber's Point and Kahe Point Beach Park.

The genus Schiedea is represented by four taxa, all endemic to O'ahu. Ma'oli'oli (S. globosa Mann var. globosa) is restricted to the spray-swept cliffs between Koko Head and Waimanalo (Degener 1932 et seq.). It prefers crevices in arid cliffs and ledges such as at Makapu'u Head. It was also reported on the rim of Kahauloa Crater (Koko Head Firing Range) (Egler 1947). Schiedea globosa var. graminifolia Deg. & Sherff in Sherff, a perhaps marginal coastal plant, has been reported from the cliffs and crevices southwest of Waimanalo Landing (Degener 1932 et seq.). Two other species of Schiedea are also marginal coastal plants but are included as they are found fairly close to the sea. Schiedea adamantis St. John is found today only on the rim of Diamond Head. Schiedea kealiae Caum & Hosaka inhabits the dry exposed cliffs along the Kealia Trail near Kawaihapai in the Ka'ena area (Degener 1932 et seq.).

Four taxa of nehe (Lipochaeta integrifolia) recognized by Sherff (1935) have been reported from O'ahu coasts:

var. integrifolia

(End. Kure, Laysan, Kaua'i, O'ahu, Maui)

var. gracilis Sherff

(End. H.I.)

var. major Sherff

(End. O'ahu)

var. megacephala Deg. & Sherff in Sherff

(End. O'ahu)

The latter three taxa were once recommended for endangered species status (USDI 1976). A fifth taxon, var. argentea Sherff, is endemic to Maui. Generally found in exposed wind-swept areas, prostrate over rocks, nehe grows near sea level to 20 to 30 m (60-90 ft) elevation. This species is distinguished by its thick succulent leaves and mat-forming habit (Gardner 1979). The four O'ahu taxa, recently consolidated into L. integrifolia by Gardner, have been reported from places such as Makapu'u, Hanauma, Ka'ena, and Popoia Island. Specimens have been collected in the past from: Waimanalo, La'ie Point, Pearl Harbor, Diamond Head (Sherff 1935); and Kailua (Hillebrand 1888). If Gardner's taxonomy is accepted, the species may not be as endangered as previously thought.

Of six coastal varieties of Lipochaeta lobata (Gaud.) DC., all were nominated at one time for endangered status except var. denticulata (Wawra) Sherff; five are endemic to O'ahu, while one is also endemic to Kaua'i (Sherff 1935). All six have been grouped into L. lobata var. lobata by Gardner (1979). According to Gardner, L. lobata var. lobata is common at Ka'ena Point and from Koko Head to Makapu'u Point in low coastal dune areas to a few hundred feet elevation on scrubby, open hillsides. Specimens of L. lobata var. lobata were noted by Gardner from Nanakuli Diamond Head crater, near Hawai'i Kai Golf Course, and Ka'ena. Other specimens have been collected from the dry, grassy eastern slopes of Kuli'ou'ou Valley and Lualualei near the beach (Degener 1932 et seq.), as well as from the Wailupe and Niu areas (Sherff 1935). Again, if Gardner's taxonomy is accepted, L. lobata var. lobata may be more common than thought earlier. Another nehe, L. remyi Gray, is considered a marginal coastal plant as it is found at 200 m (600 ft) elevation above the talus slopes at Manini Gulch, Ka'ena; it is endemic to O'ahu.

Cuscuta sandwichiana var. kailuana Yuncker, a variety of the more common kauna'oa, was once found on O'ahu as well as on Moloka'i and Hawai'i. Degener (1932 et seq.) reported it from the beach at Kailua-Kona, Hawai'i, in addition to Mo'omomi, Moloka'i, and Ka'ena Point, O'ahu. It has not been reported in recent years on O'ahu.

'Anaunau (Lepidium o-waihiense C. & S.) (mustard family, Cruciferae) is endemic to the Northwestern Hawaiian Islands, Kaua'i, O'ahu, Moloka'i, Lana'i, and Maui. Today, it is reportedly found at La'ie Point and in the Makapu'u area of O'ahu and is common in the Northwestern Hawaiian Islands.

Sicyos laysanensis St. John is endemic to Laysan and O'ahu, and was once observed at Barber's Point, 'Ewa, and Damon Tract. This plant was not mentioned in the 'Ewa Plains study (Char & Balakrishnan 1979). It was once recommended for threatened species status.

Five taxa in the genus Euphorbia ('akoko) have been reported from O'ahu coasts. All are endemic to O'ahu except E. degeneri Sherff; E. degeneri is not considered endangered at this time. Euphorbia celastroides var. kaenana Sherff is restricted to Ka'ena on the rocky slopes near the point. Euphorbia skottsbergii var. kalaeloana Sherff was thought to be extinct (Fosberg & Herbst 1975) but was rediscovered recently during botanical surveys for the Barber's Point Deep Draft Harbor (Herbst 1976). This particular 'akoko is a perennial erect shrub up to 2 m (6 ft) tall and is found now mostly among the kiawe at Barber's Point. Euphorbia skottsbergii Sherff var. skottsbergii is endemic to the 'Ewa Plains area and thought to be extinct. Forbes and Skottsberg collected this plant on the 'Ewa coral plains between 1916 and 1922 (Sherff 1936). It was last collected by Degener on the arid fossil reef between Barber's Point and Pearl Harbor in 1932. Euphorbia multiformis var. tomentella Boiss. in A. DC. is not well known. Plants of this species are normally found upland; however, it was reported along the seashore in Kailua and elsewhere by Hillebrand (1888). Fosberg and Herbst (1975) list this plant as extinct.

'Awiwi (Centaurium sebaeoides (Griseb.) Druce) Gentianaceae) is considered rare but, where found, gregarious. It is endemic to Kaua'i, O'ahu, Moloka'i, and Maui. 'Awiwi grows within reach of salt air on dry coastal plains and in sand-filled crevices of raised fossil reefs. It has been reported by Degener from La'ie Point, Hale'iwa, and Mokule'ia (Degener 1932 et seq.). It is still found in the pastureland below Manini Gulch at Ka'ena and on the steep slopes above Halona Blowhole. This species has not been officially nominated for endangered status but is identified as rare and depleted (Fosberg & Herbst 1975).

Scaevola coriacea Nutt. is a prostrate shrub with trailing branches, pale green leaves, whitish erect flowers, and black fruits (Char & Balakrishnan 1979). Hillebrand found it at Ka'ena Point on lava near the shore; it has not been seen there since 1922 (Degener 1932 et seq.). Rock found S. coriacea at Barber's Point in 1919 (Degener 1932 et seq.); it was not found in the 'Ewa Plains botanical survey (Char & Balakrishnan 1979). Once thought to be found on the arid lowlands of all the main Hawaiian Islands, S. coriacea is now restricted to the lithified dunes of Wai'ehu, Maui; a few individuals have been found recently at Kaupo, Maui.

'Ohai (Sesbania tomentosa H. & A. var. tomentosa) (pea family, Leguminosae) is an attractive shrub with large reddish flowers. Hillebrand (1888) reported it along the Wai'anae seashore on O'ahu. Degener noted it was known only from Jacquemontia-Heliotropium covered limestone and clays between the railroad tracks from Ka'ena Point to Kawaihapai. He also noted that Neal collected it at Mokapu Peninsula in 1934 (Degener 1932 et seq.). On O'ahu, this plant is now restricted to Ka'ena, amid sand dunes and coastal flats on the windward side; it is also found on Nihoa and Necker islands.

Another member of the pea family, the Oahu vigna (Vigna o-wahuensis Vogel), is endemic to Kaua'i, O'ahu, and Moloka'i. Degener, in 1934, considered it almost extinct. He found it at Waimanalo climbing over low shrubs and grasses in limestone deposits just below the cliffs (Degener 1932 et seq.). The Oahu vigna has also been observed on Mokulua Island off Lanikai.

Ma'o (Gossypium sandwicense Parl.), relative of the hibiscus, grows on arid, rocky, or clay plains not far from the sea, usually in leeward areas. On O'ahu, it is still fairly common near Koko Head and between Hono'uli'uli and Makua on the leeward coast (Degener 1932 et seq.). Ma'o is endemic to the main Hawaiian Islands.

Myoporum sandwicense var. stellatum Webster (naio) is a rare variety restricted to the 'Ewa coral plains between the mouth of Pearl Harbor and Barber's Point. Degener (1932 et seq.) noted that due to construction and other works of man, M. sandwicense var. stellatum was on the verge of extinction. Recently, it was recommended that this naio be placed on the federal list of endangered species (Char & Balakrishnan 1979).

Hedyotis littoralis (Hbd.) Fosb. (coffee family, Rubiaceae) is known from Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i (St. John 1973). There have been no recent observations or collections from O'ahu. Its typical habitat is the cliffs of Ke'anae, Maui.

Of the two varieties of coastal sandalwood ('ili-ahi-a-lo'e), Santalum ellipticum var. littorale (Hbd.) Skottsb. is considered endangered. This plant is a pale green shrub found along arid coasts among rocks and in adobe soil, and occasionally inland in drier areas (Degener 1932 et seq.). It is endemic to Laysan and O'ahu, although it is reportedly extinct on Laysan. The plant is found now at Ka'ena, Moku'auia (Goat Island), Diamond Head, and Makapu'u (near Sea Life Park). It was also formerly reported from Kailua and Wai'anae (Rock 1916).

CURRENT STATUS OF THREATENED AND ENDANGERED SPECIES

The original list of proposed endangered species expired in November 1979; a revised list of active candidates for threatened or endangered status has subsequently been republished in December 1980 (USDI 1980). Of the endemic coastal plants described above, some are being considered for official endangered species status (D. Herbst, pers. comm. 1981). The 1980 list includes the following coastal taxa:

Ophioglossum concinnum

Eragrostis paupera

Panicum fauriei

Nototrichium humile

N. viride var. subtruncatum

Capparis sandwichiana var. sandwichiana

Leptochaeta lobata var. leptophylla Deg. & Sherff in Sherff

Sicyos laysanensis

Euphorbia celastroides var. kaenana

E. skottsbergii var. skottsbergii (probably extinct)

Sesbania tomentosa var. tomentosa

Vigna o-wahuensis

Hedyotis littoralis

Two other candidates are now being proposed for endangered status: Euphorbia skottsbergii var. kalaeloana and Panicum carteri. Information is being compiled for future listing on Achyranthes splendens var. rotundata, Bidens cuneata Sherff, Scaevola coriacea, and Schiedea adamantis. A status report being prepared for Santalum ellipticum var. littorale. Futur study is planned for Marsilea villosa, a high-priority candidate.

THREATS TO NATIVE COASTAL PLANTS

There are few areas along O'ahu shores which have not been disturbed by grazing, agriculture, residential development, parks, military installations, golf courses, or coastal roads. The areas, which are relatively undeveloped such as at Ka'ena, Kahuku, Kaloko, and Barber's Point, support a significant native coastal flora with associated habitats, all of which are threatened to varying degrees.

Coastal development has permanently displaced native flora along substantial sections of O'ahu. In windward areas (e.g., Kailua-Lanikai, Waimanalo), residential development has probably displaced sizeable naupaka ecosystems. Beach park developments, such as at Sandy Beach, have replaced strand vegetation on dunes and rocky outcroppings with Bermuda grass (Cynodon dactylon (L.) Pers.) lawns and banyan trees. Golf courses like the one at Kahuku have probably displaced considerable strand vegetation on coastal dunes. Along the Wai'anae coast and between Ka'ena and Hale'iwa, coastal roads, and even railroads, were built on dunes and probably led to the loss of many native strand plants. The presence of military installations such as at Mokapu Peninsula has contributed to changes in the native shoreline vegetation.

Other undeveloped areas along the coasts have also been affected. Additional stresses placed on native coastal vegetation include grazing, erosion, and invasion by introduced lowland species.

Recreational Pressure

Today, in addition to increasing coastal development, especially for resorts, condominiums, and industrial purposes, recreational pressures pose serious threat to certain types of habitats. The relatively few uncrowded sandy beaches accessible to the public and free of major development are found farther from heavily urbanized areas such as Honolulu and Kailua-Kane'ohe, resulting in generally less disturbed environments than the more heavily used beach parks. Unfortunately, the dominant ecosystem associated with many of those rural areas--naupaka on dunes--is also popular for shoreline recreation.

The sheer impact of large numbers of people can be devastating. Parking, camping, and trampling on dunes over a long period of time can cause erosion, blow-outs, and dune movement. One study (Vogt 1979) found that fewer than 10,000 people walking over sand dunes in a single season could eliminate dune plants and cause sand erosion. At popular beach parks (e.g., Makapu'u), the effects of heavy recreational use (e.g., completely eroded dunes) are readily apparent. Nearby Sandy Beach also shows longterm effects of vehicular and pedestrian traffic, including parking.

Off-road Recreational Vehicles (ORVs)

The effects of people can hardly compare with the impacts of off-road recreational vehicles such as jeeps, 4-wheel drives, motorbikes, and dune buggies. Ironically, ORVers appear to share with bikers and other non-motorized recreationists a desire to get away from the urban life and confining jobs, into the wilderness and open space (U. S. CEQ 1979). Unfortunately, the ORVers create substantial impacts on fragile habitats (e.g., dunes). One study (NEMAS 1980) concluded that there is no carrying capacity for vehicular traffic on coastal ecosystems. Even low-level impacts can result in severe environmental degradation. In many test areas, it was found that the first few vehicle passes did the most damage. Another five-year experimental study conducted at Cape Cod National Seashore between 1974 and 1977 examined the impacts of 4-wheel drive vehicles on beaches, dunes, salt marshes, and tidal flats (Godfrey et al. 1978). This study concluded that the driftlines and developing dunes were the most susceptible to ORV damage. A few ORV passes could break up the concentrated organic deposit from beachdrift and destroy regenerating plants just below the sand surface.

Similar ORV damage appears to be occurring at the seaward edge of dune ecosystems. For example, at Makapu'u, Sandy Beach, and Kaloko, where pohuehue, or the beach morning glory, and naupaka-kahakai should be common, the vegetation line appears to have been moved inland by ORV traffic on the beach itself. ORV tracks and vegetation damage can be observed at the vegetation line.

Coastal lowlands are also vulnerable to ORV damage although the substrate may be more durable than dunes. ORV traffic in some areas (e.g., Ka'ena) has resulted in a vast network of tracks and eroded areas.

Invasion of Introduced Flora

Finally, invasion of disturbed habitats by introduced plants is a great concern. Introductions of aggressive plants (e.g., koa-haole, Pluchea, and kiawe) have led to their dominance in many coastal areas. Richmond and Mueller-Dombois (1972) noted that "...with disturbance, dryland floristic elements, notably Prosopis and Chloris (finger grass), have displaced the typical strand flora to a very narrow zone along the coastline, although a few species may persist under Prosopis with low cover." They also observed that the "undergrowth of Prosopis ecosystems is dominated by introduced drought-resistant grasses and shrubs. However, in Scaevola ecosystems, except under extremely disturbed conditions the native strand flora have persisted (emphasis added)." Preventing the disturbance of their habitats, then, is crucial to protecting native strand plants. For example, a study by Takemoto (1977) of vegetation changes at Ka'ena Point between 1966 and 1977 concluded that:

1. Jeeps and other motor vehicles caused more unvegetated open areas in the 11-year period;
2. Naupaka cover was significantly reduced;

3. Much of the loss included native herbs and vines between naupaka clumps and at the edges of the clumps;
4. The plants most vulnerable to vehicle damage included alena, 'akoko, hinahina-ku-kahakai, and 'ilima;
5. Koa-haole invasion had begun mostly on the leeward side of the naupaka clumps; the koa-haole's deeper root system was thought to be more resistant to damage.

SPECIAL CONCERNS

Although there are reportedly pockets of native coastal flora along O'ahu's coastline (e.g., Makahoa Point, Hau'ula, La'ie Point, Pahumoa ["Pounders"], and some offshore islands), there are few significant areas remaining. Three areas urgently need protection: Ka'ena Point, Kalaeloa (Barber's Point), and 'Ihi'ihilauakea on Koko Head. Other areas having considerable native coastal flora include Kaloko ("Alan Davis" or "Queen's Beach") and Makapu'u Beach Park. Certain areas, although rather rich with native coastal plants, need management less urgently due to less accessibility and human pressures. Those areas include the Makapu'u spray-swept cliffs and upper talus slopes of the Ka'ena area.

Ka'ena

Recent concern for the rare and endangered flora at Ka'ena has been partly responsible for proposals for a state park and natural area reserve there. Kimura and Nagata (1980) describe the variety of native coastal plants found at Ka'ena, as well as the different habitats ranging from sand dunes to talus slopes. Among a number of endangered plants in the area at least three are of special interest:

<u>Euphorbia celastroides</u> var. <u>kaenana</u>	'Akoko
<u>Lipochaeta lobata</u> var. <u>lobata</u>	Nehe
<u>Sesbania tomentosa</u> var. <u>tomentosa</u>	'Ohai

The 'akoko at Ka'ena is locally common on the slopes between rock outcroppings. As this 'akoko is restricted to Ka'ena, it deserves special attention. During a May 1980 field survey, a number of damaged plants were observed on the lower slopes near the dirt road. People collecting rocks for stone walls may be rolling the rocks over the plants.

Lipochaeta lobata var. lobata may also be endemic to Ka'ena according to Sherff (1935). However, Gardner (1979) believes this nehe is the same as other L. lobata varieties found along other O'ahu coastlines. In either case, the Ka'ena nehe is unusual because of its deeply-lobed leaves. Fortunately, it appears relatively safe from human impacts as it grows mostly on slopes protected by rock outcroppings; however, some plants along the road are threatened by introduced weeds.

The 'ohai at Ka'ena is probably the most threatened of the three plants as it is found mostly on the coastal flats potentially in the path

of ORVs, especially near the point. A May 1980 field survey located over 100 individual plants distributed between the point and the Mokule'ia end of the paved road; 86 were at the point in exposed areas near the dunes where ORVs are regularly driven. Immovable boulders strategically placed in the vicinity may help to protect this population of 'ohai.

In addition to the rare and endangered plants at Ka'ena, the naupaka on dune ecosystems also deserve attention. ORVs have decimated the dunes in recent years, adding to the damage incurred by vehicles and human trampling over many decades since the turn of the century. Increasing ORV use has accelerated destruction of the Ka'ena dunes and has altered the landscape considerably as well as the flora. ORV use should generally be controlled in the area.

Kalaeloa (Barber's Point)

Richmond and Mueller-Dombois (1972) noted that the endemic flora of the native dry forest, which may have extended to the coast in leeward areas, is one of the most vulnerable elements of O'ahu's coastline vegetation. The 'Ewa fossil reef plains are the most extensive of its kind in the Hawaiian Islands and represent a unique ecosystem. Kimura and Nagata (1980), and Char and Balakrishnan (1979) both describe the area in terms of climate, geology, environments, and flora. The beach flora at Barber's Point is not exceptional, especially due to substantial disturbances by development, trampling, ORVs, and invasion of exotic plants. However, a number of rare and endangered plants, located slightly inland from the beach, are of special interest:

<u>Achyranthes splendens</u> var. <u>rotundata</u>	
<u>Capparis sandwichiana</u> var. <u>zoharyi</u>	Maiapilo
* <u>Eragrostis paupera</u> Jedw.	An endemic grass
<u>Euphorbia skottsbergii</u> var. <u>kalaeloana</u>	'Akoko
* <u>E. skottsbergii</u> var. <u>skottsbergii</u>	'Akoko
<u>Gossypium sandwicense</u>	Ma'o
<u>Marsilea villosa</u>	An endemic fern
<u>Myoporum sandwicense</u> var. <u>stellatum</u>	Naio
<u>Ophioglossum concinnum</u>	Pololei,
	an endemic fern
* <u>Scaevola coriacea</u>	Naupaka

Three of the plants, indicated by an asterisk (*), are no longer thought to be found in the area; two of them, Eragrostis paupera and Euphorbia skottsbergii var. skottsbergii, are endemic to Barber's Point.

Marsilea villosa and pololei, both described earlier, have not been observed in this area since 1932 and 1912, respectively, but may have been overlooked in field surveys due to their seasonal growth (Char & Balakrishnan 1979). Ma'o is thought by several botanists to be less endangered than initially recommended; it is locally common in dry leeward coastal areas such as the Wai'anāe coast. Maiapilo or native caper, is not considered endangered, unlike var. sandwichiana found at Ka'ena. However, it is rather rare on O'ahu except in this general vicinity where approximately 140 plants are found.

This leaves three plants still found at Barber's Point of special interest. Euphorbia skottsbergii var. kalaeloana, needs attention urgently as it is found mostly in the back-up area for the proposed Barber's Point Deep Draft Harbor. Of the approximately 4400 plants located, 2450 are in the immediate project area. Another 1300 is found where the West Beach resort has been proposed, and approximately 100 were destroyed when a parcel next to the Chevron Oil Refinery was bulldozed in 1979. Assuming that all of the proposed developments proceed, the best management options are to find a suitable habitat and successfully propagate the plant for transplanting, as recommended by Char and Balakrishnan (1979).

The other two plants of concern are the Achyranthes and Myoporum (naio). The Achyranthes is endemic to O'ahu and though a few individuals have been seen at Ka'ena, it is found mostly in the Barber's Point area. There are two main colonies at Barber's Point. Approximately 600 plants are located among the Pluchea and kiawe between the cement and fertilizer plant buildings; another 500 are near the lighthouse; and about 115 less vigorous plants are under kiawe in the Malakole Military Reservation.

Finally, as described earlier, the Myoporum is a variety found only at Barber's Point. Most of the plants are found generally in the same areas as the Achyranthes. A kiawe community adjacent to the Barber's Point Beach Park harbored some of the aforementioned Achyranthes, maiapilo, and naio. However, a roadside clearing and the development of a parking lot for an adjacent lu'au operation destroyed an unknown number of these plants within the last two years. A sanctuary has been proposed to preserve examples of plants native to the unique 'Ewa plains area (Char & Balakrishnan 1979).

'Ihi'ihilauakea

A third area in need of special protection is 'Ihi'ihilauakea, a wet depression above Hanauma Bay. It is the habitat for the small endemic fern Marsilea villosa which has been nominated for endangered species status. Aside from the Barber's Point population, whose status is uncertain, this may be the last major population on O'ahu. However, within the last two years, motorbikes have found their way into this area and have begun to damage the habitat. Today, tire ruts, tire scars, and campfire sites mark the presence of recreationalists. In some of the disturbed areas, particularly in tire ruts, weeds such as cocklebur (Xanthium) are beginning to appear while other weeds and various grasses are beginning to encroach upon the habitat margins. Measures should be taken soon to bar vehicular entry and to control trampling; campfires should also be restricted to prevent fires during the dry season. Invading weeds such as the cocklebur may need to be removed periodically.

Kaloko and Makapu'u Beach Park

Kaloko ("Alan Davis" or "Queen's Beach"), which is owned by the Bishop Estate and has been proposed for resort development, is a prime field trip site for the study of native coastal plants as well as for other ocean-related subjects. A diverse number of native strand plants can be found at Kaloko including alena, kauna'oa, 'akoko, Fimbristylis,

hinahina-ku-kahakai, nena, pohuehue, pa'u-o-Hi'i-aka, nehe, 'ohelo-kai, nama, naupaka-kahakai, 'ilima, 'aki'aki, and nohu. Ma'o and naio are also found nearby. Few places on O'ahu are so close to Honolulu schools and offer a safe field trip environment with such a diversity.

The 1980 State Legislature appropriated \$1 million for parkland acquisition at Queen's Beach; the appropriation lapses in June 1982. Past appropriations to the State totalling \$2.1 million between 1975 and 1977 for land acquisition lapsed through June 30, 1980. Additional appropriations to the City and County of Honolulu have similarly lapsed. The current appropriation should be used to purchase selected portions of Bishop Estate lands as soon as possible before the Queen's Beach resort development proceeds. The area could be managed as an official coastal field trip site for the primary and secondary schools on O'ahu.

Makapu'u Beach Park is already publicly owned and also has some potential as a field trip site due to its excellent tide pools and interesting geology and coastal flora. The dune areas are severely damaged by ORVs and heavy recreational pressures; however, a number of common strand plants still persist, including 'akoko, hinahina-ku-kahakai, nena, 'ili-ahi-a-lo'e, naupaka-kahakai, and nohu. If ORVs and other vehicles are restricted from the dune areas and heavy recreational pressure is diverted to less sensitive areas, perhaps portions of the original dunes could recover or be restored.

Other Recommendations

In addition to the recommendations provided for specific coastal areas, general recommendations are offered for consideration:

1. Naupaka ecosystems, found primarily in wind-exposed parts of O'ahu, should be generally protected from intensive recreational activity--particularly vehicular and pedestrian traffic. ORVs should be prohibited, perhaps by county ordinance, from operating on dunes and sandy beaches. Walkover structures for beach access through dunes should also be considered, especially for public parks.

2. General locations of the native coastal flora should be mapped and incorporated into the City and County's shoreline management area (SMA) to ensure that any development which may adversely affect native coastal habitats will be adequately reviewed. The City and County's Department of Land Utilization, in cooperation with the State of Hawaii, was developing a map to note the locations of rare and endangered coastal plants for boundary revision purposes in 1980.

3. Research should be conducted on the effects of ORVs and trampling on the Hawaiian coastal flora. There is no available information applicable to Hawai'i which could be used to improve the management of sensitive coastal environments.

4. Native coastal flora, particularly on publicly owned lands, should be documented. A management program should be developed by appropriate agencies to protect significant habitats. Baseline data

need to be collected for areas such as Ka'ena and periodic surveys should be conducted to monitor changes caused by recreational and other uses and to evaluate on-going management efforts. Maintenance personnel should be made aware of the existence of special plants on the premises in order to avoid accidental clearing or weeding.

5. Native coastal flora and habitats should be restored whenever possible as part of the landscaping of county beach parks--especially those suited for strand vegetation (e.g., Sandy Beach and Makapu'u). Such restoration projects would help to reestablish the former native vegetation, as well as reduce maintenance and operational costs (e.g., watering, weeding, mowing). Those areas would also be valuable for public educational purposes. Botanical gardens featuring coastal plants (e.g., the Maui Zoo and the Waha'ula Visitor Center, Hawaii Volcanoes National Park) could be an extension of this approach.

6. Public education is needed to increase the awareness and appreciation of Hawaii's unique coastal plants and to illustrate their contribution to our well-being. Wise decisions affecting future use of areas harboring native plants will depend on having an informed public.

CONCLUSIONS

At one time, O'ahu had considerably more native coastal flora along its beaches and coastal lowlands. Grazing, cultivation, development, roads, and other disturbances have eliminated many coastal habitats and encouraged invasion by introduced plants. Today, recreational pressures and continued development threaten the remaining native coastal flora. What remains today is still impressive; however, the future of certain plants is uncertain.

A few plants at Ka'ena, Barber's Point, and Koko Head appear to require more urgent attention. More generally, naupaka ecosystems need more effective management to prevent further deterioration from ORVs and intensive recreational pressure. Kaloko and Makapu'u Beach Park, among others, should be considered for coastal field trip sites and managed accordingly. Finally, public education is needed to ensure the perpetuation of habitats necessary for native coastal plants.

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NATIVE COASTAL PLANTS OF O'AHU, HAWAI'I

- Pteridophyta -

MARSILEACEAE
(Water Fern Family)

Marsilea villosa Kaulf. Endemic

Range: O'ahu, Moloka'i.

Distribution on O'ahu: Koko Head; photographed at Barber's Point in 1932; observed at Nanakuli, Makapu'u and Lualualei from 1925-33.

Protection Recommended: Federal Register (1975,1976) - Endangered, (1980) Endangered, Category 1; Fosberg & Herbst (1975) - Depleted, Local, Rare, Endangered, Cultivated.

OPHIOGLOSSACEAE
(Adder's Tongue Family)

Ophioglossum concinnum Brack. Endemic
pololei

Range: O'ahu, Lana'i, Moloka'i, Maui and Hawai'i.

Distribution on O'ahu: Unknown, not collected recently.

Protection Recommended: Federal Register (1975,1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Very Rare, Endangered.

Note: Last collected by Forbes and Cooke near Sisal, Ewa in 1912.

ADIANTACEAE
(Maidenhair Fern Family)

Doryopteris decora Brack. Endemic
'iwa'iwa, kumunui

Range: Hawaiian Islands.

Distribution on O'ahu: Makapu'u.

- Anthophyta -

Monocotyledonae

CYPERACEAE
(Sedge Family)

Cyperus javanicus Houtt. ?Indigenous
marsh cypress, 'ahu'awa, 'ehu'awa

Range: India through Polynesia.

Distribution on O'ahu: Barber's Point, Mokule'ia near Camp Erdman.

Cyperus laevigatus L. ?Indigenous
smooth flatsedge, makaloa sedge, makaloa, 'ehu'awa

Range: Cosmopolitan throughout the tropics.
Distribution on O'ahu: Kahuku.

Cyperus trachysanthos H. & A. Endemic
sticky galingale

Range: Kaua'i, Ni'ihau, O'ahu, Moloka'i, Lana'i.
Distribution on O'ahu: Ka'ena. Observed by Degener at
Kuli'ou'ou-Makapu'u, Ulupa'u, Ka'ena and Kawaihapai from
1925 to 1932.
Protection Recommended: Fosberg & Herbst (1975) - Depleted.

Fimbristylis pycnocephala Hbd. Indigenous
coastal sedge

Range: Hawaiian Islands to Solomon Islands, Laysan.
Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point and Kahuku Pt.

GRAMINAE (POACEAE)
(Grass Family)

Eragrostis paupera Jedw. Endemic

Range: O'ahu.
Distribution on O'ahu: Barber's Point, not collected recently.
Protection recommended: Federal Register (1975, 1976) -
Endangered, (1980) - Endangered, Category 1; Fosberg &
Herbst (1975) - Probably Extinct.

Eragrostis variabilis (Gaud.) Hbd. Endemic
'emoloa, kalamalo, kawelu, variable lovegrass

Range: Hawaiian Islands including the Leeward Islands.
Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, and Diamond
Head.

Heteropogon contortus (L.) Beauv. ex R. & S. Indigenous
pili, pili grass, twisted beard grass, tanglehead

Range: India and Polynesia.
Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, and Makapu'u.

Panicum carteri Hosaka Endemic

Range: O'ahu, Moloka'i, and Hawai'i.
Protection recommended: Federal Register (1975) - Extinct,
(1980) - Endangered, Category 1; Fosberg & Herbst (1975) -
Probably Extinct.

Panicum fauriei Hitchc. Endemic
Faurie's panicgrass

Range: Moloka'i, Hawai'i, and O'ahu.

Distribution on O'ahu: Koko Head-Kaloko (?); Makapu'u (?);
observed on Popoia Island.

Protection Recommended: Federal Register (1975, 1976) -
Endangered, (1980) - Endangered, Category 2; Fosberg &
Herbst (1975) - Local, Depleted, Endangered.

Panicum nubigenum Kunth Endemic

Range: O'ahu, Moloka'i, Lana'i, and Hawai'i.

Distribution on O'ahu: Mokulua Island off Lanikai and above
Hanama Bay on slopes.

Panicum torridum Gaud. Endemic
kakonakona, torrid panicgrass

Range: Leeward Islands, O'ahu to Hawai'i.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, and
Diamond Head.

Sporobolus virginicus (L.) Kunth Indigenous
'aki'aki, beach dropseed, seashore rushgrass, manienie-
maoli, manienie-'aki'aki

Range: Pantropic.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point, Kahuku Point.

PANDANACEAE
(Screw Pine Family)

Pandanus odoratissimus L.f. var. odoratissimus
Indigenous/Endemic
pandanus, screw pine, hala, puhala

Range: Hawaiian Islands and Ceylon.

Distribution on O'ahu: Kahana Valley.

Dicotyledonae

AIZOACEAE

Sesuvium portulacastrum (L.) L. Indigenous
'akulikuli, sea purslane

Range: Tropics.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Barber's Point,
and Kahuku Point.

AMARANTHACEAE
(Amaranth Family)

Achyranthes splendens var. rotundata Hbd.

Endemic

Range: O'ahu.

Distribution on O'ahu: Ka'ena, Barber's Point, and Popoia Island (?).

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Very Rare, Very Local, Endangered, Cultivated.

Note: Major population at Barber's Point.

Nototrichium humile Hbd. var. humile
kulu'i, Kaala nototrichium

Endemic

Range: O'ahu.

Distribution on O'ahu: Ka'ena, not collected recently.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Depleted, Very Rare, Endangered.

Note: Noted by J.F. Rock. Collected by Hillebrand at Ka'ena.

Nototrichium humile var. subrhomboideum Sherff
kulu'i

Endemic

Range: O'ahu.

Distribution on O'ahu: Ka'ena.

Protection Recommended: Federal Register (1976) - Endangered; Fosberg & Herbst (1975) - Very Rare, Endangered.

Note: Variety consolidated in N. humile by St. John (1979).

Nototrichium sandwicense (Gray in Mann) Hbd. var. sandwicense
Endemic
kulu'i, Hawaiian nototrichium

Range: O'ahu, Kaua'i, Moloka'i, Maui, Lana'i, and Hawai'i.

Distribution on O'ahu: Ka'ena (Manini Gulch at top of talus slopes).

Protection Recommended: Fosberg & Herbst (1975) - Very Rare, Endangered.

Nototrichium viride var. subtruncatum Sherff
kulu'i

Endemic

Range: O'ahu.

Distribution on O'ahu: Ka'ena, not collected recently.

Collected in 1950 by Hatheway and Degener from sea level to 1,200 ft. between Mokule'ia and Kawaihapai.

Protection Recommended: Federal Register (1975, 1976) - Endangered; Fosberg & Herbst (1975) - Very Rare, Endangered.

Note: Consolidated in N. viride by St. John (1979).

ARALIACEAE
(Ginseng Family)

Reynoldsia sandwicensis var. intercedens Sherff Endemic
 'ohe'makai

Range: O'ahu.

Distribution on O'ahu: Ka'ena, behind Dillingham Airfield on windward talus slopes.

Protection Recommended: Federal Register (1975, 1976) - Endangered; Fosberg & Herbst (1975) - Very Local, Very Rare, Very Depleted, Endangered.

Note: This taxon is considered a synonym of R. sandwicensis by St. John.

BORAGINACEAE
(Heliotrope Family)

Heliotropium anomalum H. & A. var. argenteum Gray Indigenous
 hinahinakakahakai

Range: Pacific Islands.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, Barber's Point, and Kahuku Point.

Protection Recommended: Fosberg & Herbst (1975) - Depleted, Local, Endangered, Declining, Cultivated.

Heliotropium curassavicum L. Indigenous
 nena, kipukai, hinahina, seaside heliotrope

Range: Hawaiian Islands and the Americas.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, Barber's Point, and Kahuku Point.

Protection Recommended: Fosberg & Herbst (1975) - Depleted, Local, Very Rare.

CAPPARACEAE
(Caper Family)

Capparis sandwichiana DC. var. sandwichiana Endemic
 maiapilo, puapilo, native caper

Range: O'ahu.

Distribution on O'ahu: Ka'ena; Mokule'ia to Makapu'u; observed on Popoi'a and Kekepa Islands, and Pounder's Beach on Hau'ula Island.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Very Rare, Very Local, Endangered.

Capparis sandwichiana var. zoharyi Deg. & Deg. Endemic

Range: Midway Island to Hawaiian Islands.

Distribution on O'ahu: Barber's Point; observed at Kahe Point Beach Park.

Protection Recommended: Fosberg & Herbst (1975) - Depleted, Protected, Cultivated.

CARYOPHYLLACEAE
(Pink Family)

Schiedea adamantis St. John Endemic

Range: O'ahu.

Distribution on O'ahu: Diamond Head (localized on north rim).

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Very Rare, Very Local, Endangered.

Schiedea globosa Mann var. globosa Endemic
ma'oli'oli, kawelu, globose schiedea

Range: O'ahu.

Distribution on O'ahu: Koko Head and Makapu'u.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 3C; Fosberg & Herbst (1975) - Very Rare, Very Local, Endangered, Cultivated.

Schiedea globosa var. graminifolia Deg. & Sherff Endemic

Range: O'ahu.

Distribution on O'ahu: Waimanalo (reported from talus slopes).

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 3C; Fosberg & Herbst (1975) - Rare, Endangered.

Schiedea kealiae Caum & Hosaka Endemic
(=S. gregoriana Deg.)
ma'oli'oli, kawelu

Range: O'ahu.

Distribution on O'ahu: Ka'ena; noted by D. Mueller-Dombois and Degener in Kawaihapai-Ka'ena area, Kealia Trail.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Rare, Local, Endangered.

CHENOPODIACEAE
(Goosefoot Family)

Chenopodium oahuense (Meyen) Aellen Endemic

Range: Hawaiian Islands.

Distribution on O'ahu: Ka'ena; observed on Mokumanu Island and One'awa Beach, Kailua.

COMPOSITAE (ASTERACEAE)
(Sunflower Family)

Artemisia hillebrandii Skottsb. Endemic
hinahina

Range: O'ahu.

Distribution on O'ahu: Ka'ena (top of windward talus slopes).

Protection Recommended: Fosberg & Herbst (1975) - Uncommon.

Aster sandwicensis (Gray) Hieron. Endemic

Range: Kaua'i, O'ahu, Moloka'i, and Maui.

Protection Recommended: Federal Register (1975, 1976) -
Endangered, (1980) - Endangered, Category 1; Fosberg &
Herbst (1975) - Very Rare, Uncommon, Probably Extinct.

Bidens cuneata Sherff Endemic
kokoolau, cuneate bidens

Range: O'ahu.

Distribution on O'ahu: Diamond Head (endemic to rim of crater).

Protection Recommended: Federal Register (1975, 1976) -
Endangered, (1980) - Endangered, Category 1; Fosberg &
Herbst (1975) - Very Local, Very Rare, Endangered.

Lipochaeta integrifolia (Nutt.) Gray var. integrifolia Endemic
nehe

Range: Kure, Laysan, Kaua'i, O'ahu, and Maui.

Distribution on O'ahu: Ka'ena; Koko Head-Kaloko; Makapu'u;
Kahuku Point; collected from Waimanalo, La'ie Point,
Popoi'a, Pearl Harbor, Diamond Head.

Lipochaeta integrifolia var. gracilis Sherff Endemic

Range: Hawaiian Islands.

Distribution on O'ahu: Unknown.

Protection Recommended: Federal Register (1975) - Extinct,
(1976) - Endangered, (1980) - Endangered, Category 3B;
Fosberg & Herbst (1975) - Very Rare, Endangered, Probably
Extinct.

Note: Collected by Gaudichaud in 1836. Consolidated in L.
integrifolia by Gardner (1979).

Lipochaeta integrifolia var. major Sherff

Endemic

Range: O'ahu.

Distribution on O'ahu: Makapu'u; collected from Waimanalo, Makapu'u, and Diamond Head.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 3B; Fosberg & Herbst (1975) - Local, Depleted, Endangered.

Note: Variety consolidated in L. integrifolia by Gardner (1979).Lipochaeta integrifolia var. megacephala Deg. & Sherff

Endemic

Range: O'ahu.

Distribution on O'ahu: Ka'ena (collected by Degener in 1931).

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 3B; Fosberg & Herbst (1975) - Very Local, Endangered.

Note: Variety consolidated in L. integrifolia by Gardner (1979).Lipochaeta lobata (Gaud.) DC. var. lobata
nehe, lobed lipochaeta

Endemic

Range: O'ahu.

Distribution on O'ahu: Ka'ena; collected from Kuli'ou'ou and Luualualei.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 3C; Fosberg & Herbst (1975) - Depleted, Endangered.

Lipochaeta lobata var. albescens Sherff

Endemic

Range: O'ahu.

Distribution on O'ahu: Unknown. Collected by Heller from Diamond Head in 1895.

Protection Recommended: Federal Register (1975) - Extinct, (1976) - Endangered, (1980) - Endangered, Category 3B; Fosberg & Herbst (1975) - Rare, Endangered, Possibly Extinct.

Note: Variety consolidated in L. lobata (Gaud.) DC. var. lobata by Gardner (1979).Lipochaeta lobata var. aprevalliana (Drake) Sherff

Endemic

Range: O'ahu.

Distribution on O'ahu: Makapu'u; collected by Degener near Kalama Valley in 1931.

Protection Recommended: Federal Register (1975) - Extinct, (1976) - Endangered, (1980) - Endangered, Category 3B; Fosberg & Herbst (1975) - Rare, Probably Extinct.

Note: Variety consolidated in L. lobata (Gaud.) DC. var. lobata by Gardner (1979).

Lipochaeta lobata var. denticulata (Wawra) Sherff Endemic

Range: Kaua'i and O'ahu.

Distribution on O'ahu: Ka'ena; Makapu'u; collected from Waimanalo- Koko Head and Wailupe-Diamond Head; common on Kamehame Ridge at 1,100 ft. elevation.

Lipochaeta lobata var. hastulata (H. & A.) Sherff Endemic

Range: O'ahu.

Distribution on O'ahu: Ka'ena; collected by Degener in 1931 at Kawaihapai Ridge near Ka'ena.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 3B; Fosberg & Herbst (1975) - Very Local, Very Rare, Endangered.

Note: Variety consolidated in L. lobata (Gaud.) DC. var. lobata by Gardner (1979).

Lipochaeta lobata var. leptophylla Deg. & Sherff Endemic

Range: O'ahu.

Distribution on O'ahu: Ka'ena (talus slopes); collected from Niu-Wailupe and Kipapa.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Depleted, Endangered.

Note: Variety consolidated in L. lobata (Gaud.) DC. var. lobata by Gardner (1979).

Lipochaeta remyi Gray Endemic
nehe

Range: O'ahu.

Distribution on O'ahu: Ka'ena; observed near Manini Gulch at 600 ft.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 3C; Fosberg & Herbst (1975) - Rare Endangered.

CONVOLVULACEAE
(Morning-glory Family)

Cressa insularis House Indigenous
native cressa

Range: Hawaiian Islands, Socorro Island, Clarion Island, and California.

Distribution on O'ahu: Found in sandy areas near Pearl Harbor.

Protection Recommended: Fosberg & Herbst (1975) - Very Rare, Endangered.

Cuscuta sandwichiana Choisy var. sandwichiana Endemic
kauna'oa, kauna'oalei, dodder

Range: Hawaiian Islands.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point.

Cuscuta sandwichiana var. kailuana Yuncker Endemic

Range: O'ahu, Moloka'i, and Hawai'i.

Distribution on O'ahu: Ka'ena (not collected recently).

Note: Recorded from the seashore at Kailua-Kona, Hawai'i;
Mo'omomi; and Moloka'i.

Ipomoea brasiliensis (L.) Sweet Indigenous
(=I. pes-caprae)
pohuehue, beach morning-glory

Range: Pantropic.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point and Kahuku Point.

Ipomoea cairica (L.) Sweet var. cairica Indigenous
koali

Range: Hawaiian Islands and tropical Asia.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point, and Diamond Head.

Ipomoea congesta R. Br. Indigenous
(=I. indica)
koali'awania, koaliawa, morning glory

Range: Hawaiian Islands, Windward Islands, Australia, Pacific
Islands, and Mexico.

Distribution on O'ahu: Ka'ena, Barber's Point, and Diamond Head.

Ipomoea stolonifera (Cyrill.) J.F. Gmel. Indigenous
hunakai, white-flowered beach morning glory

Range: Hawaiian Islands, tropical America, and Pacific Islands.

Distribution on O'ahu: Barber's Point, Kahuku Point, and Magic
Island.

Ipomoea tuboides Deg. & Van Ooststr. var. tuboides f. tuboides
Endemic
Hawaiian moonflower

Range: Hawaiian Islands.

Distribution on O'ahu: Ka'ena.

Jacquemontia sandwicensis Gray var. sandwicensis Endemic
pa'uohi'iaka

Range: Hawaiian Islands.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, and Barber's Point.

CRUCIFERAE
(Mustard Family)

Lepidium o-waihiense C. & S. Endemic
(= L. bidentatum Mont. var. o-waihiense (C. & S.) Fosb.)
'anounou, 'anaunau

Range: Leeward Islands, Kaua'i, O'ahu, Moloka'i, Lana'i, and Maui.

Distribution on O'ahu: Makapu'u (northern cliffs).

Protection Recommended: Federal Register (1975, 1976) -
Endangered, (1980) - Endangered, Category 3C; Fosberg &
Herbst (1975) - Depleted, Very Rare, Endangered, Cultivated,
Probably Extinct.

Note: Common in Leeward Islands.

CUCURBITACEAE
(Squash Family)

Sicyos laysanensis St. John Endemic
(= Cladocarpa laysanensis)

Range: Laysan and O'ahu.

Distribution on O'ahu: Barber's Point (not collected recently).

Protection Recommended: Federal Register (1975) - Threatened,
(1980) - Endangered, Category 1; Fosberg & Herbst (1975) -
Very Local, Possibly Endangered, Protected.

Note: Previously reported from Ewa and Damon Tract.

Sicyos microcarpus Mann Endemic
kupala

Range: O'ahu and Kaua'i.

Distribution on O'ahu: Ka'ena, Barber's Point, and scattered
locations along Wai'anae coast (e.g. Kea'au).

EUPHORBIACEAE
(Spurge Family)

Euphorbia celastroides var. kaenana Sherff Endemic
'akoko

Range: O'ahu.

Distribution on O'ahu: Ka'ena.

Protection Recommended: Federal Register (1975, 1976) -
Endangered, (1980) - Endangered, Category 1; Fosberg &
Herbst (1975) - Local, Endangered.

Euphorbia degeneri Sherff var. degeneri Endemic
'akoko, koko, beach spurge

Range: Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, and Kahuku Point.

Protection Recommended: Fosberg & Herbst (1975) - Depleted, Cultivated.

Euphorbia skottsbergii var. kalaeloana Sherff Endemic
'akoko

Range: O'ahu.

Distribution on O'ahu: Barber's Point (recently rediscovered).

Protection Recommended: Federal Register (1975) - Extinct, (1976) - Endangered, (1980) - Proposed; Fosberg & Herbst (1975) - Probably Extinct.

Euphorbia skottsbergii Sherff var. skottsbergii Endemic
'akoko

Range: O'ahu.

Distribution on O'ahu: Barber's Point (not collected recently).

Protection Recommended: Federal Register (1975) - Extinct, (1976) - Endangered, 1980 - Endangered, Category 1; Fosberg & Herbst (1975) - Local, Very Rare, Possibly Extinct.

Note: Last observed in 1932.

GENTIANACEAE
(Gentian Family)

Centaurium sebaeoides (Griseb.) Druce Endemic
awiwi, Hawaiian erythraea

Range: Kaua'i, O'ahu, Moloka'i, and Maui.

Distribution on O'ahu: Ka'ena (in pastures below Manini Gulch); observed by Degener at La'ie Point, Hale'iwa, and Mokule'ia; reported from Koko Head on tuff slopes and at Halona Blowhole (mauka side).

Protection Recommended: Fosberg & Herbst (1975) - Depleted, Rare, Cultivated.

GOODENIACEAE
(Naupaka Family)

Scaevola coriacea Nutt. Endemic
naupaka, false jadetree

Range: Hawaiian Islands.

Distribution on O'ahu: Ka'ena (not seen since 1922) and Barber's Point. (last observed in 1919).

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Very Local, Very Rare, Endangered, Cultivated.

Scaevola taccada var. sericea (Vahl.) St. John Indigenous
naupakakahakai, beach naupaka, huahekili, half-flower, beach
scaevola

Range: Hawaiian Islands, tropical Pacific and Indian Oceans.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point, and Kahuku Point.

HYDROPHYLLACEAE
(Water-leaf Family)

Nama sandwicensis Gray Endemic
Hawaiian nama, Laysan nama

Range: Hawaiian Islands.

Distribution on O'ahu: Koko Head-Kaloko, Makapu'u, and Barber's
Point.

Protection Recommended: Fosberg & Herbst (1975) - Depleted,
Rare, Declining.

LAURACEAE
(Laurel Family)

Cassytha filiformis L. Indigenous
kaunoa'oa, kaua'oapehu, kauna'oa'malolo, kauna'oauka

Range: Cosmopolitan in Tropics.

Distribution on O'ahu: Ka'ena and Barber's Point.

LEGUMINOSAE (FABACEAE)
(Pea Family)

Canavalia galeata (Gaud.) Vogel Endemic
'awikiwiki, puakauhi

Range: O'ahu.

Distribution on O'ahu: Ka'ena (reported in upland dry forest),
Makapu'u, and La'ie Peninsula.

Cassia gaudichaudi H. & A. Indigenous
uhiuhi, kalamona, kolomona, Solomon in all his glory

Range: Hawaiian Islands and Tahiti.

Distribution on O'ahu: Talus slopes behind Sea Life Park.

Note: This lowland species was noted by J. F. Rock.

Erythrina sandwicensis Deg. var. sandwicensis Endemic
wiliwili, Hawaiian erythrina, Hawaiian coral tree

Range: Hawaiian Islands.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, and Barber's
Point.

Sesbania tomentosa H. & A. var. tomentosa f. tomentosa Endemic
'ohai, O'ahu sesbania

Range: O'ahu, Kaua'i, Moloka'i, Lana'i, Hawai'i, Necker, and Nihoa.

Distribution on O'ahu: Ka'ena; observed makai of Makua Cave in 1930's or 1940's; at Mokapu Peninsula by M. Neal in 1934.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Depleted, Rare, Endangered, Protected, Cultivated.

Vigna marina (Burm.) Merr. Indigenous
nanea, pohilihili, mohihihi, 'okole-makili, beach pea

Range: Tropics.

Distribution on O'ahu: Koko Head-Kaloko and Kahuku Point.

Vigna o-wahuensis Vogel Endemic
O'ahu vigna

Range: Kaua'i, O'ahu, and Moloka'i.

Distribution on O'ahu: Observed on Mokulua near Lanikai in 1930's; at Waimanalo below cliffs by Degener in 1934.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Local, Very Rare, Endangered.

MALVACEAE
(Mallow Family)

Abutilon incanum (Link) Sweet Indigenous
hoary abutilon

Range: Hawaiian Islands and Mexico.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, and Barber's Point.

Abutilon menziesii Seem. Endemic

Range: Lana'i, Maui, Hawai'i, and O'ahu(?).

Distribution on O'ahu: Barber's Point (one specimen observed in an abandoned canefield).

Protection Recommended: Federal Register (1975) - Extinct, (1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Declining, Rare, Endangered, Cultivated.

Gossypium sandwicense Parl. Endemic
(=G. tomentosum Nutt.)
ma'o, native cotton, huluhulu

Range: Hawaiian Islands.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Barber's Point, Nanakuli, and Diamond Head (floor of crater).

Protection Recommended: Federal Register (1975, 1976) -
Endangered, (1980) - Endangered, Category 3C; Fosberg &
Herbst (1975) - Cultivated, Depleted, Rare, Endangered.

Hibiscus tiliaceus L. var. tiliaceus f. tiliaceus Indigenous
hau

Range: Tropical Pacific and Old World.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Barber's Point,
Kahana and Kahuku Point.

Sida fallax Walp. var. fallax f. fallax Indigenous
'ilima

Range: Hawaiian Islands, Pacific Islands, and China.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point, and Kahuku Point.

Note: The genus Sida is currently under revision by St. John.

MENISPERMACEAE
(Moonseed Family)

Cocculus ferrandianus Gaud. Endemic
huehue, hue'ie, 'inalua

Range: O'ahu and Hawai'i.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, and Barber's
Point.

MYOPORACEAE
(Naio Family)

Myoporum sandwicense Gray subsp. sandwicense var. sandwicense
Endemic
naio, bastard sandalwood

Range: Kaua'i, Ni'ihau, O'ahu, Moloka'i, Maui, and Lana'i.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, and Diamond
Head (rim near crest).

Myoporum sandwicense var. stellatum Webster Endemic
naio

Range: O'ahu.

Distribution on O'ahu: Barber's Pt.

Protection Recommended: Recommended by Char and Balakrishnan for
endangered species status - restricted to Barber's Pt.

NYCTAGINACEAE
(Four O'Clock Family)

Boerhavia diffusa L.
alena

Indigenous

Range: Tropics.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point, and Kahuku Point.

Note: The genus Boerhavia is under revision.

PAPAVERACEAE
(Poppy Family)

Argemone glauca Pope var. glauca
puakala, kala, pokalakala, naule, prickly poppy

Endemic

Range: Kaua'i to Maui.

Distribution on O'ahu: Koko Head-Kaloko and Makapu'u.

PLUMBAGINACEAE
(Leadwort Family)

Plumbago zeylanica L.
'ilie'e, hilie'e, kupukupu'ula, wild plumbago

Indigenous

Range: Tropics of Eastern hemisphere.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, and Barber's
Point.

PORTULACACEAE
(Purslane Family)

Portulaca cyanosperma Egler
'ihi, blue-seeded portulaca

Endemic

Range: Kaua'i, Lehua, O'ahu, and Hawai'i.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u,
Barber's Point, and Diamond Head (rim of crater).

Portulaca lutea Soland. ex Forst. f.
'ihi, native yellow portulaca

Indigenous

Range: Pacific islands.

Distribution on O'ahu: Ka'ena.

Protection Recommended: Fosberg & Herbst (1975) - Depleted,
Rare, Cultivated.

Portulaca villosa Cham.

Endemic

Range: Nihoa, Ka'ula, O'ahu, and Molokini.

Distribution on O'ahu: Koko Head-Kaloko; observed at Manana;
found at Hanama in 1920's.

Protection Recommended: Fosberg & Herbst (1975) - Local, Rare,
Cultivated.

PRIMULACEAE
(Primrose Family)Lysimachia mauritiana Lam.

Indigenous

Range: Hawaiian Islands and Pacific and Indian Ocean shores.

Distribution on O'ahu: Unknown.

Note: Noted J.F. Rock. This genus is under revision by St. John.

RHAMNACEAE
(Buckthorn Family)Colubrina asiatica (L.) Brongn.
'anapanapa, kukuku

Indigenous

Range: Kaua'i, Ni'ihau, O'ahu, Moloka'i, Africa, India, and Australia to Polynesia.

Distribution on O'ahu: Reported on road between Waialua and La'ie; by Degener in Kuli'ou'ou Valley.

Note: Noted by J.F. Rock.

RUBIACEAE
(Coffee Family)Canthium odoratum (Forst. f.) Seem.
alahe'e, walahe'e, plectronia

Indigenous

Range: Hawaiian Islands, Polynesia, and Fiji.

Distribution on O'ahu: Ka'ena (reported on windward talus slopes and gulches).

Hedyotis littoralis (Hbd.) Fosb.

Endemic

Range: Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i.

Distribution on O'ahu: Not observed on O'ahu recently.

Protection Recommended: Federal Register (1975, 1976) -

Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Depleted, Rare, Endangered.

Note: Locally common at Ke'anae, Maui.

SANTALACEAE
(Sandalwood Family)Santalum ellipticum Gaud. var. ellipticum
'iliahialo'e, coast sandalwood

Endemic

Range: Hawaiian Islands.

Distribution on O'ahu: Barber's Point.

Protection Recommended: Fosberg & Herbst (1975) - Depleted.

Santalum ellipticum var. littorale (Hbd.) Skottsb. Endemic
'iliahialo'e

Range: Laysan and O'ahu.

Distribution on O'ahu: Ka'ena; Makapu'u; reported from Moku'auia (Goat Island) in 1930's; found on Diamond Head below road, on makai slopes, and on south rim.

Protection Recommended: Federal Register (1975, 1976) - Endangered, (1980) - Endangered, Category 1; Fosberg & Herbst (1975) - Very Depleted, Endangered.

Note: Extinct on Laysan.

SAPINDACEAE
(Soapberry Family)

Sapindus oahuensis Hbd. Endemic
aulu, kaulu, lonomea

Range: O'ahu.

Distribution on O'ahu: Ka'ena (reported on windward talus slopes and gulches) and Barber's Point (one specimen observed).

SCROPHULARIACEAE
(Figwort Family)

Bacopa monniera (L.) Wettst. Indigenous
water hyssop, herpestris

Range: Tropics and warm regions.

Distribution on O'ahu: Makapu'u and Kahuku Point.

Note: Found in wetlands and on beaches (e.g., Ka'a'awa).

SOLANACEAE
(Nightshade Family)

Lycium sandwicense Gray Indigenous
'ohelokai, 'ae'ae, 'akulikuli'ae'ae, 'akulikuli'ohelo

Range: Hawaiian Islands and Polynesia.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, and Barber's Point.

Protection Recommended: Fosberg & Herbst (1975) - (Depleted, Local, Protected, Cultivated).

STERCULIACEAE
(Cocoa Family)

Waltheria americana L. Indigenous
hi'āloa, 'ūhaloa, kanakaloa

Range: Hawaiian Islands.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, Barber's Point, and Kahuku Point.

VERBENACEAE
(Verbena Family)

Vitex ovata Thunb. Indigenous
pohinahina, polinalina, kolokolokahakai, beach vitex

Range: Hawaiian Islands, Asia, and Pacific Islands.

Distribution on O'ahu: Ka'ena, Barber's Point, and Kahuku Point.

ZYGOPHYLLACEAE
(Tribulus Family)

Tribulus cistoides L. Indigenous
nohu, nohunohu, large-flowered caltrop

Range: Cosmopolitan in Tropics.

Distribution on O'ahu: Ka'ena, Koko Head-Kaloko, Makapu'u, and Barber's Point.

References and Sources for Checklist

1. The checklist is not intended to be comprehensive. Only native plants reported or observed along O'ahu coastlines are included; listed plants include lowland and dry forest species with ranges extending down to the coast.

2. Status and Range: The information is primarily from St. John.

3. Distribution on O'ahu: Notable areas are listed; this information is not intended to be all inclusive. Primary sources include: Ka'ena - Hawai'i, Division of State Parks (1978); Koko Head to Kaloko - Fosberg (1961), Richmond & Mueller-Dombois (1972); Makapu'u - Fosberg (1961), Richmond & Mueller-Dombois (1972); Barber's Point - Char & Balakrishnan (1979); Kahuku Point - Elliot & Hall (1978). Other observations and special sites were provided by Derral Herbst, Winona Char, Carolyn Corn, Ken Nagata, Wayne Souza, and Paul Weissich. Their generous assistance is gratefully acknowledged.

4. Protection Recommended: Federal Register - 1975 information from U.S. Dept. of the Interior (1975), 1976 information from USDI (1976), 1980 information from USDI (1980) (categories are explained below); Fosberg & Herbst assessment from Fosberg & Herbst (1975); other recommendations for Myoporum sandwicense var. stellatum Webster from Char & Balakrishnan (1979).

5. The 1980 Federal Register contained a revised and expanded system of categories for listed species. Those categories, abbreviated in the checklist, may be interpreted as follows: Category 1 = candidate taxa with sufficient biological information for listing, Category 2 = candidate taxa with

insufficient biological information for listing, Category 3 = taxa no longer considered for listing (3a = taxa considered extinct, 3b = taxa not meeting designation of "species", 3c = taxa considered widespread or abundant).

SOCIETY CORRESPONDENCE

April 16, 1980

Dear President,

Day after day, week after week, month after month, Kona residents have been able to witness the results of the carnage of native Hawaiian forests in Kona as lumber trucks bearing enormous ohia logs, some 4-5 feet in diameter and over 40 feet long, make their way out of South Kona through Kailua and on to Kawaihae where the logs will be chipped and sent to Japan for pulp.

The destruction of these native Hawaiian forests in Kona continues at an alarming rate. I do not believe that it is necessary to explain to you that Hawaii can ill-afford to lose more of its already vanishing forests which support rare and endangered bird and plant life in addition to harboring potential, badly needed water resources.

The logging of ohia forest in Kona resulting in complete destruction of the forest is being done by Capitol Wood Chip Co. under sanctioning and on land owned by the Bishop Estate and Mac Nuts of Hawaii, Inc. In addition, native koa forest is being logged and destroyed by Campbell-Burns Wood Products on land owned by Donn Carlsmith-Captain Cook Investment Co.

Unfortunately, all these logging operations are taking place on private lands, hence there is little that can be done currently to legally put a stop to them. I felt that all members of the Hawaiian Botanical Society should be informed of this senseless destruction. Perhaps as more concerned people become aware and express their sentiments opposed to these operations, some action can be taken that will eventually result in the opening of new legislative and/or legal channels to put an end to this destruction. If we do not start now, the destruction will continue: Capitol Wood Chip Co., represented by Big Island County Councilman, Steve Yamashiro, has applied to the State of Hawaii for logging concessions on 10,000 acres of ohia forest in Kona on State-owned land.

President, perhaps as the initial step, you would be kind enough to read this letter at the next meeting of the Hawaiian Botanical Society and ask for a show of support on the record of the members in condemnation of the parties and practices involved in these logging operations. It is only a start and we could work from there.

Don Hodel
Kealahou, HI

NOXIOUS WEEDS IN HAWAII

Dr. I. A. Abbott has suggested that it would be very useful if the Society could produce a list of weeds which members consider to be the most noxious in the state. For this purpose, we are providing ten blank spaces below for each member to list their 'favorites' for this dubious honor. Candidates should be entered with the most villainous first and all others ranked accordingly. You may use either the common name or the scientific name.

If you wish to confine your list to any particular island you may do so by circling the island name. You may submit separate lists for different islands. Please provide your name and address and/or a telephone contact number so that we can clarify any name problems. The results will be compiled in subsequent Newsletters and updated as entries are received. We ask that you make only one entry for any particular island or the state as a whole. You may subsequently amend your original entry. We will automatically remove your previous entry on receipt of any subsequent listing. We ask as many of our members as possible to enter a list. The greater the number of entries the less the bias in the results and hopefully the more likely we can reach a consensus. With luck we may be able to convince the State of Hawaii Department of Agriculture to amend their list of noxious weeds to include those species listed by the Society.

This form can be cut out of your Newsletter and folded in three. The return address is already printed on the reverse of the sheet for your convenience.

Island: Kauai, Oahu, Molokai, Lanai, Hawaii, Hawaiian Islands (Circle one only please)

Name: _____

Address or telephone number: _____

Editor
Hawaiian Botanical Newsletter
c/o Department of Botany
University of Hawaii at Manoa
3190 Maile Way
HONOLULU HI 96822

Minutes: May 7, 1979 Meeting

The meeting was called to order by President Woolliams at 7:37 p.m.

Old business--No news has been received concerning the Vicia menziesii controversy; the society hopes to hear from Mr. Lyman later on.

New business--The president was informed by a letter from Mae Mull that Dr. Otto Degener has received recognition for his work on the flora of the Hawaiian Islands and conservation by the Hawaii State Legislature (Senate Bill 294).

The president asked for suggestions for future field trips. He noted that one of our previous speakers, Mr. Fred Trotter, had invited the society to visit the Alice Kamokila Campbell Estate in 'Ewa.

Steve Montgomery asked that the society urge our Congressmen to support the Udall-Anderson House Bill to protect Alaskan lands from development. The society agreed to support the bill and Steve is to send a telegram to our Congressmen expressing our support.

The Science Fair judges this year were Keith Woolliams, Dan Palmer, and Winona Char. The two Science Fair winners were announced. They were:

Intermediate level: Jacqueline Amai, 7th grader at Kawananakoa Intermediate School, whose project was "A new source of energy--Algae Briquettes"

Senior level: Marie Pechous, 10th grader at Leilehua High School, whose project was "Does Clidemia hirta produce an allelopathic chemical?"

Dr. Manhoff presented a motion that the Hawaiian Botanical Society create the position of President Emeritus, and that the position be a lifelong award and that the first recipient of that honor should be Dr. Harold St. John. There were no objections and the motion was unanimously approved.

The business portion of the meeting was concluded at 7:55 p.m. The "Plant-of-the-month" speaker was then introduced. Elizabeth Rabakanandrianina spoke about the endemic genus Lipochaeta, a member of the Compositae.

President Woolliams then introduced Dr. Theobald, director of Pacific Tropical Botanical Garden (PTBG). May's meeting was a joint meeting between the Society and PTBG. Dr. Theobald then introduced the speaker for the evening, Dr. Benjamin C. Stone, who spoke on the "Plants and places of Malaysia."

Respectfully submitted,
Winona P. Char, Secretary

Minutes: June 4, 1979 Meeting

The meeting was called to order at 7:35 p.m. by Vice-president Balakrishnan since the president was away on a trip. The June meeting is the last meeting before the summer recess.

Announcements for the Wahiawa Botanic Garden tour were made. The tour is scheduled for July 28, at 9:45 a.m.

Ray Baker, a member of the Hawaiian Palm Society, announced the date of the Palm Society's July meeting and invited the Society's members to attend.

June was plant exchange month.

The vice-president then announced the "Plant-of-the-month" speaker, Mr. Tim Lowery, from the University of California at Berkeley, who spoke on Tetramolopium, a native Compositae. The genus is comprised of 12 species and 7 varieties.

Mr. Thomas Lumpkin with the Department of Agronomy and Soil Sciences, University of Hawaii, was introduced by the vice-president. Mr. Lumpkin spoke on "Highlights of a botanical trip through tropical America."

Respectfully submitted,
Winona P. Char, Secretary

Minutes: October 1, 1979 Meeting

The October meeting is the first meeting held after the summer recess.

The meeting was called to order by President Woolliams at 7:35 p.m. The president read a letter from Representative Daniel Akaka thanking the society for its concern about passage of the Alaskan land bill. The society was in favor of the bill. The telegram to Representative Akaka had been drafted by Steve Montgomery.

This year's nominating committee members are Mr. Ted Green, Mr. Paul R. Weissich, and Dr. Pieter van Royen.

Dr. Dan Palmer will audit the Society's books this year.

A membership and dues drive is currently being actively pursued. The Newsletter is becoming more costly to publish each year especially if members are delinquent in payment of their dues! Dr. Clifford Smith, editor of the Newsletter, would like to have more articles from the Society members. The President announced that the Newsletter will be reduced from 5 to 3 issues per year, however, the number of pages will remain the same. This will cut down on the number of mailings and postage costs. The Society has considered bulk mailing but this would require at least 200 paid members off campus. A great number of the Society's

membership is composed of people at the University and to save postage the Newsletter is sent through campus mail which is free.

President Woolliams has spoken to the people who run the ServiceScope ads. Free advertisement time on television will be given to the Society in January 1980.

The president expressed his concern about the spiraling whitefly problem. This pest was recently introduced to the islands and has spread very rapidly on O'ahu. Very few plants are not affected to some degree. Though no plants appear to be severely affected by the whiteflies directly, the copious growth of sooty mildews in the honeydew released by the white flies may decrease photosynthesis in some species. The aesthetic appeal of affected plants is certainly diminished. Also, rubbing up against an affected plant results in one's clothes, skin or hair being covered with a sticky mess of honeydew, whiteflies and sooty mold. An inordinate number of complaints have reached various state agencies. The State's Department of Agriculture is in the process of activating a program to find and introduce biological control agents for this pest. Local biologists are particularly concerned that this new introduction may have brought some plant diseases along with it or act as a vector for diseases already present but without a suitable vector.

The Federal Government proposes to change a section of its importation act concerning Cocos nucifera. The change would allow coconuts to be imported into Hawaii and other parts of the U. S. from Jamaica. The secretary drafted a letter expressing the Society's concern about allowing the importation of coconuts into Hawaii from Jamaica where the deadly lethal yellowing of palms is known to occur. Our native loulou palm (Pritchardia) is especially vulnerable to lethal yellowing. If lethal yellowing were established in Hawaii it would literally wipe-out most of our coconut trees. The spiraling whitefly which is a vector of the disease is also present in Hawaii.

The 1979 Botany Student of the Year Award for the senior who will reflect credit on the Science of Botany was presented to Molly Olive Morrison.

Dr. Dan Palmer who has hiked extensively on O'ahu and who is also on the Native Plant Committee was introduced by the vice-president for the "Plant-of-the-month" presentation. Dr. Palmer talked about Drypetes phyllanthoides (Euphorbiaceae), an endemic forest tree on the verge of extinction.

The vice-president then introduced the speaker for the evening, Mr. Paul Kores formerly with the Wau Institute of Ecology. Mr. Kores spoke about the "Rhododendrons of Papua New Guinea."

Respectfully submitted,
Winona P. Char, Secretary

Minutes: November 5, 1979 Meeting

The meeting was called to order by President Woolliams. The slate of officers nominated for 1980 was announced by the president as follows:

President:	Ms. Evangeline Funk
Vice-president:	Mr. Ray Baker
Secretary:	Ms. Julie Williams
Treasurer:	Mr. Lowell Funk
Directors:	Mr. Keith Woolliams, Mr. N. Balakrishnan

President Woolliams announced that there has been no up-date from the Bishop Estate concerning the plight of the endangered Vicia menziesii. The president thanked Mr. William and Mrs. Mary Bush for their monetary donation to the Society.

Dr. Gressitt, Wau Institute of Ecology-New Guinea, has again asked the Marie Neal Fund for funds to support its education program. His letter will be submitted to the Trustees of the Neal Fund for consideration. The Society gave the Wau Institute \$100.00 from the Marie Neal Fund last year with the stipulation that the monies be spent specifically for their education program.

Ms. Maile Stemmermann announced that the Audubon Society would be celebrating its 40th anniversary and that a special film about the Galapagos Islands would be shown at the Mid-Pacific Auditorium November 6, at 7:30 p.m.

The secretary, in place of the absent vice-president, then announced the "Plant-of-the-month" speaker, Mr. Paul Kores, who spoke about the Lobelias of Waialeale, Kaua'i.

Dr. Derral Herbst also announced that four more species have been officially listed as endangered. Three of the species are confined to a small kipuka (Kipuka Kalawamauna) in the Pohakuloa Training Area, island of Hawai'i. They are Lipochaeta venosa, Haplostachys haplostachya var. angustifolia (thought to have been extinct), and Stenogyne angustifolia var. angustifolia. The fourth plant, Kokia cookei, endemic to Molokai, is now extinct in the wild and one plant in the Waimea Arboretum is all that remains of this species.

The speaker for the evening was then introduced by the secretary. Dr. Sheila Conant, Assistant Professor with the General Science Department, U.H. Manoa, spoke about the "Native birds in Hawaii's National Parks."

Respectfully submitted,
Winona P. Char, Secretary

Minutes: December 3, 1979 Meeting

The meeting was called to order at 7:35 p.m. by President Woolliams. The annual report for 1979, was presented by Secretary Char. Vice-President Balakrishnan presented the membership report for the year: total membership 345, of which 27 are honorable members. For 1979, paid up membership totaled 110. Suggestions were offered for prompt dues payment. The treasury report for 1979 was presented by Treasurer Funk.

Dr. Dan Palmer was attending a convention in Chicago, therefore, no Native Plants Committee report will be given until his return.

A Foster Botanical Garden sponsored trip was announced to Southeast Asia from 2/29/80 until 3/24/80. Dr. Lamoureux will be the trip leader.

President Woolliams announced an award given to Dr. Degener by the German Botanical Society for his botanical work in Hawaii and Fiji.

John Obata presented the first annual Hawaii Botanical Society awards to Dr. Harold St. John, Ms. Beatrice Krauss, and Dr. Oscar Kirsch.

President Woolliams announced the election of Hawaii Botanical Society officers for 1980. A motion was made that all nominees be unanimously accepted. The motion was seconded. Officers for 1980 are: Evangeline Funk - President; Ray Baker - Vice-President; Lowell Funk - Treasurer; Julie Williams - Secretary. Directors are Keith Woolliams and N. Balakrishnan.

Beatrice Krauss spoke on the plant of the month, Coprosma ernodeoides.

Keith Woolliams was speaker of the evening. His presentation was on the "Flora of Ogasawara Islands."

Respectfully submitted,
Julie Williams, Secretary

RECENTLY COMPLETED THESES
IN BOTANICAL SCIENCES
AT
THE UNIVERSITY OF HAWAII

MADISON, Margaret W. 1979. Enterokinase Inhibitors in Plants

Nineteen tissues representing 15 species of plants were assayed for trypsin inhibitory activity. Twenty-one tissues as well as purified lima bean and soybean trypsin inhibitors were assayed for enterokinase inhibitory activity to determine whether or not enterokinase is among herbivore digestive proteinases targeted by plant proteinase inhibitors. Of the tissues assayed, 14 contained trypsin inhibitory activity. Enterokinase inhibitory activity was found in four tissues, including leaves of a tomato hybrid and a cultivar (Lycopersicon esculentum Mill. cv. Bonnie Best and N-52 hybrid) and tubers of two potato cultivars (Solanum tuberosum L. cv. Russet Burbank). Preliminary work suggests the accumulation of enterokinase inhibitory activity in L. esculentum cv. Bonnie Best leaves as a result of wounding and the presence of several enterokinase inhibitors in the Solanaceae.

MAGRUDER, William H. 1977. An ecological study of the red alga Ahnfeltia concinna (Rhodophyta, Gigartinales)

In the Hawaiian Islands, Ahnfeltia concinna is a perennial macroscopic seaweed found only on basalt coastlines where it often forms a dense band high in the littoral zone. The location and factors affecting the coverage of the substratum by the gametophyte band were measured at three sites with different exposures to waves and swells along the northeast coast of the island Hawaii. At wave and swell exposed sites, the vertical distance of the band above tidal datum was greater on high angle shores than on low angle shores. At wave and swell sheltered sites, the vertical distance of the band above tidal datum was equal on shores of all angles. A closed population occurred only in areas where water flowed through the fronds. This occurred on both high and low angle shores at exposed sites. Neither grazing nor water salinity affected the coverage of the substratum by the fronds. The lengths of the fronds were measured at the three sites. The longest fronds occurred at the most wave and swell exposed site and the shortest fronds occurred at the most wave and swell sheltered site. At each site, the fronds on low angle shores were longer than the fronds on high angle shores. At exposed sites, the longest fronds occurred at the lower edge of the band while at sheltered sites the fronds at the lower edge of the band were shorter than the fronds in the middle of the band due to grazing. Observations on the causal factors of the vertical limits of the band were made. The upper limit of the band is determined by desiccation. Fronds at the upper edge of the band are killed when very small waves and swells, neap tides, and no cloud cover occur simultaneously. The causal factor of the lower limit of the band is not obvious, but competition for surface area with other algae and grazing may be important.

SMITH. Celia M. 1978. Photorespiration in selected marine members of the chlorophyta in Hawaii: Identification of the Glycollate oxidizing enzyme system

In demonstrating glycollate oxidation by ten tropical marine siphonous algae and two freshwater algae, the siphonous representatives were shown to catalyze the reaction by glycollate dehydrogenase activity on the basis of its lactic acid stereospecificity, cyanide inhibition, and cofactor requirements. Both freshwater algae Chara and Spirogyra, possessed glycollate oxidase. The specific activity range among the algae varied from 0 to 13.9 nmol.min⁻¹.mg protein⁻¹. The significance of glycollate dehydrogenase and glycollate oxidase distribution as phylogenetic markers is discussed.

STEMMERMANN, R. Leilani. 1977. Studies of the vegetative anatomy of the Hawaiian representatives of Santalum (Santalaceae), and observations of the genus Santalum in Hawaii.

The vegetative anatomy of the Hawaiian representatives of the genus Santalum (Santalaceae) was studied. Wood and foliar anatomy of all species has been described. Consistent differences in wood anatomy among taxa were not detected, but certain anatomical features of leaves differed significantly. Characteristics of leaf anatomy that were of taxonomic value were the bottle-shaped adaxial epidermal cells of S. haleakalae, the papillate nature of the abaxial leaf surface of several taxa, and the presence of adaxial as well as abaxial stoma in S. ellipticum. One new taxon, and two new combinations, are proposed based on observations of the genus in the field, herbarium studies, and on anatomical differences found in this study.

A Resolution on the Problem of Goats
in Haleakala National Park

Whereas, a primary goal of Hawaii's National Parks is the protection of native biota under pristine conditions; and

Whereas, recently Haleakala National Park has been nominated as an Earth Biosphere Reserve; and

Whereas, endemic Hawaiian flora and fauna are unique and should be preserved for study and enjoyment by everyone; and

Whereas, the spectacular Haleakala silversword as well as several rare Geraniums, mosses, and other plants are restricted to Haleakala National Park and are adversely affected by feral goats; and

Whereas, the continued survival of the insects, over 20 percent of which are unique to the Crater, is seriously threatened by loss by habitat; and

Whereas, National Parks are established "to preserve for all time scenic beauty, wilderness, native wildlife, indigenous plant life and areas of scientific significance for antiquity"; and

Whereas, man, through the introduction of feral animals, has severely altered Hawaiian ecosystems; and

Whereas, nearly one-half of the birds presently listed as endangered by the U. S. Fish and Wildlife Service are Hawaiian and many of these depend directly on the remaining portions of native habitat now threatened by exotic animals and plants; and

Whereas, there are several endangered bird species whose critical habitats are being disrupted by this neglect in the Park; and

Whereas, experimental exclosures, from which feral goats have been excluded, have demonstrated a rapid recovery of native vegetation within the protected areas; and

Whereas, the present use of deputized hunters who are not immediately supervised, not trained, nor selected for their shooting or back country ability, is probably in direct opposition to National Park Service policy, as is the perpetuation of destructive non-native animals within National Parks; and

Whereas, the present goat management problem in Hawaii is of national significance, with implication and precedents available to all National Parks; and

Whereas, 25 miles of incremental fencing are indicated for 1980 fiscal year on page 17 of Haleakala National Park/Hawaii Revised Draft Environmental Statement, Proposed General Management Plan, United States Department of the Interior/National Park Service; and

Whereas, money for completion of fencing of the Park has not been forthcoming; and

Whereas, numerous Cooperative Park Studies Unit, University of Hawaii (CPSU/UH) and independent scientific studies of resource-management problems in Haleakala National Park repeatedly recognize goats as a major factor and recommend their immediate eradication or removal; and

Whereas, the resource-management capabilities are being severely hampered by this lack of monetary support and consequent cutbacks of resource-management personnel; and

Whereas, goats are recognized by the Hawaii National Parks resource managers as the major perturbation in the Parks; and

Whereas, some duties of resource-management personnel have been diluted to encompass maintenance functions of little or no consequence to the primary resource-management problems in Haleakala National Park; and

Whereas, elimination of feral goats in Hawaii Volcanoes National Park appears to have been a fait accompli due primarily to the efforts of that Park's resource-management personnel and the backing of the conservation groups in procuring funds for boundary and internal fencing; and

Whereas, the Hawaiian Botanical Society is disappointed with this continuing neglect of Haleakala National Park; and

Whereas, any future attempts at reestablishing or rehabilitating damaged native ecosystems, as has been implemented at Hawaii Volcanoes National Park, will come to naught without protection;

NOW THEREFORE BE IT RESOLVED that the Hawaiian Botanical Society at its monthly meeting on 21 April 1980 urges the National Park Service to immediately seek funding to complete fencing of the Crater District of Haleakala National Park against feral goats; and

BE IT FURTHER RESOLVED that goats and other feral animals be eliminated from within the boundaries of Haleakala National Park as the fencing of the Park is accomplished; and

FINALLY BE IT RESOLVED that copies of this resolution be sent to Hawaii's Congressional delegation, Governor Ariyoshi, USFWS Office of Endangered Species, Secretary of the Interior, Director of the National Park System, Superintendent of Haleakala National Park, and the news media.

ANNUAL REPORT OF THE SECRETARY - 1979

1979 marked the 55th year for the Society. The officers for 1979 were:

President -	Keith Woolliams
Vice-president -	Nadarajah Balakrishnan
Secretary -	Winona Char
Treasurer -	Lowell Funk
Directors -	John Obata, Dr. Gerald Carr

The year saw an increase in membership dues passed by the Society. This was due largely to the spiraling costs of publishing and mailing the Newsletter. A membership drive was also initiated. The Newsletter will be reduced from 5 to 3 issues per year to save on expenses, however, the number of pages will remain the same per volume. Plant donation will be held 4 times per year instead of 3 to provide enough funds for the cookie and punch social hour after the meeting.

In conservation matters the Society was quite active. The Society strongly supported the need for a biological control for Clidemia hirta, a noxious weed which has over-grown many areas on O'ahu and has recently been found on Maui and Hawai'i. The Society recommended to the Bishop Estate that the 50 acres which contain the endangered Vicia menziesii (Hawaiian vetch) be set aside for the preservation of the species. President Woolliams has been in contact with some of the Estate's trustees concerning preservation of the Vicia. The Society expressed support in favor of the Udall-Anderson House Bill in Congress. This bill would protect Alaskan lands from development. The Society also contributed to the funding of a poster in observance of National Wildlife Week in Hawai'i.

A field trip to the Wahiawa Botanical Garden was made by members on July 28.

The Society awarded copies of Rock's "Indigenous Trees of the Hawaiian Islands" to the two Science Fair winners. The books were donated by Pacific Tropical Botanical Garden.

The Botany student of the year award went to Ms. Molly Morrison.

The speakers for the past year were:

January - Dr. Charles H. Lamoureux (U.H., Dept. of Botany):
"Why are there so many endangered species in Hawaii?"

February - Dr. C. E. Jones (California State University):
"Pollination in plants"

March - Mr. Mark Merlin (U.H., Dept. of General Science):
"Natural origins and early cultural history of the opium poppy"

April - Mr. Richard Carpenter (East-West Center Research Institute):
"Environmental assessment and economic development"

May - Dr. Benjamin C. Stone (this was a joint meeting between the Society and P.T.B.G.): "Plants and

The June meeting was the last meeting before the summer recess. The Society resumed its regular meetings in October.

October - Mr. Paul Kores (formerly with the Wau Institute, New Guinea): "Rhododendrons of Papua-New Guinea"

November - Dr. Sheila Conant (U.H., Dept. of General Science): "Native birds in Hawaii's National Parks"

December - Presidential address by Mr. Keith Woolliams (Waimea Arboretum): "Flora of Ogasawara Islands."

Respectfully submitted,
Winona P. Char, Secretary

TREASURER'S REPORT FROM NOV. 30, 1978 TO NOV. 30, 1979

We began the year with \$864.42 in our checking account, \$10,360.91 in the Marie C. Neal Memorial account (# C-718689) in First Federal Savings and Loan Assn., and \$168.98 in the Hawaiian Botanical Society account (# 102586) in First Federal Savings and Loan Assn.--a total of \$11,394.31.

During this year we have received in dues, gifts, etc. \$869.00. During this year we spent \$1048.70, leaving a balance of \$684.72 in our checking account.

There were no withdrawals from the savings accounts, and the interest that has accumulated during this year has not yet been added as I have not had time to take the passbooks to First Federal to have it entered.

The money was spent as follows:

Postage	\$288.57
Maps	153.75
Wau Ecology Institute	100.00
Office Supplies	282.99
Typing Service	183.99
Telegrams	11.80
Prizes	27.60
	<u>\$1048.70</u>

Respectfully submitted,
Lowell Funk, Treasurer

Minutes: February 4, 1980 Meeting

President Funk called the meeting to order at 7:30 p.m. A final decision was announced regarding those members who had not paid their dues. They will be sent a card calling attention to their membership status which will also act as a final notice. If no response is received within a reasonable amount of time, their Newsletter subscription and meeting notices will be terminated.

The auditor's report was presented. The books were found to be in order during the period of November-December, 1979.

Dr. Smith made a request for article contributions to the Botanical Society Newsletter. He noted that without articles there will be no Newsletter. He suggested that people consider filing notes on field trips, visitors to the Islands, notes on shows and exhibitions. He also recommended that members consider sending in notes on horticultural interests and concerns, e.g. it would be interesting if someone would summarize the recent spiraling whitefly outbreak and control.

A request for volunteers was made for the March meeting's refreshment preparation. A suggestion to hold a joint meeting with Pacific Tropical Botanical Garden on the second Monday in March was approved.

The upcoming Albert L. Tester Memorial Symposium was announced. It will take place on April 10th and 11th at the East-West Center.

Anita Manning, Registrar at the Bishop Museum, requested volunteer researchers to work on the organization of collections now being stored at the Museum. There are a large number of collections that need unpacking, accessioning and prepared for inclusion in the main collection.

Steve Montgomery of the Conservation Council for Hawaii announced Hawaii Wildlife Week which will take place at the end of March. He requested a donation for educational materials to be disbursed during Wildlife Week. A motion was made and seconded to donate \$50.00.

Discussion then turned to a Marie Neal Memorial Trustee who moved to the mainland. Questions whether this trustee should be allowed to continue on the board arose. It was decided that the secretary would write to the person and inquire about her intended status.

The plant of the month talk was presented by Jim Sorenson. The subject was the phenology of Andropogon virginicus. The talk was a synopsis of his M.S. thesis.

The speaker of the month was Dr. Lyndon Wester of the U.H. Geography Department. His subject was invasion by adventives in Hawaii.

Respectfully submitted,
Julie Williams, Secretary

Minutes: March 10, 1980 Meeting

In the absence of President Funk, the joint meeting with the Pacific Tropical Botanical Garden was called to order at 7:35 p.m. by Vice-President Baker.

A joint Botanical Society-Audubon Society meeting was approved for April 21, 1980.

The next plant donation will be at the April meeting.

On April 9, 1980, Winona Char and Ruth Gay were Hawaii Botanical Society judges for the 23rd Annual Hawaiian Science and Engineering Fair. Awards were given in two divisions.

The Senior division winner was Bertha Doar, Kamehameha School. Her project was entitled "Does Ulva have a place in the alcohol race?"

The Intermediate division award went to Jonathan Ohta from Aiea Intermediate School. The title of his project was "Oleander, an insecticide."

These winners will each receive a copy of Rock's Indigenous Trees of Hawaii and their school will receive a year's subscription to the Hawaiian Botanical Society Newsletter.

Dr. Peter Raven was speaker of the month. His title was "Tropical Conservation: a Worldwide Perspective."

Respectfully submitted,
Julie Williams, Secretary

Minutes: April 21, 1980 Meeting

The joint meeting of the Society and the Hawaii Audubon Society was called to order by Dr. S. Conant, President of the Audubon Society. Mrs. Funk was unable to attend the meeting due to a serious illness of one of her daughters.

April was Plant Donation Month.

Steve Montgomery spoke about National Wildlife Week and the Conservation Council for Hawaii. Liebert Landgraf will talk at their annual meeting May 22, at the Waikiki-Kapahulu Library. Dr. Fred Scrodden, President of the National Wildlife Federation, will also speak.

Dr. Conant announced Dr. Cliff Smith as Speaker of the Month. His topic was resource management in Haleakala National Park.

During a discussion after the presentation it was proposed by Dr. W. Gagne that a resolution deploring the continued depredation of goats in Haleakala National Park be sent to the National Park Service, the U.S. Department of the Interior, and the Hawaiian Congressional Delegation. A

rough draft was approved subject to minor editorial changes later. The text of the resolution is printed elsewhere in this Newsletter.

Julie Williams, Secretary

Minutes: May 5, 1980 Meeting

The meeting was called to order at 7:35 by Vice-President Baker. A letter from President Funk was read in which she submitted her resignation for personal reasons. Following Hawaiian Botanical Society by-laws, Vice-President Baker was named President. A request for Vice-Presidential nominations was put forth, however, no nominations were made. It was agreed by the membership that nominees would be named at the June meeting.

Wayne Gagne read the final form of the resolution on the goat eradication program at Haleakala National Park. The membership unanimously agreed to support the proposal.

President Baker read a letter from Don Hodel protesting the logging of native ohia forests in South Kona. It was agreed that further information would be gathered before the Botanical Society would take an official stand.

request from the Library of the Academy of Sciences of the USSR to exchange journals was approved after some discussion.

Wayne Gagne also asked for support for a monk seal protection proposal. This was unanimously approved by the Botanical Society. A public hearing on the proposal will be held later this month by the U.S. Fish and Wildlife Service. The current proposal was expected to meet some disapproval from the State government which wishes to develop the Leeward islands for commercial fishing. The Hawaiian monk seal is a very timid animal that cannot tolerate human disturbance.

The speakers of the month included the three directors of botanical gardens on Oahu--Paul Weissich from Honolulu Botanical Garden; Bob Hirano, Acting Director of Lyon Arboretum; and Keith Woolliams from Waimea Arboretum.

Respectfully submitted,
Julie Williams, Secretary

Minutes: June 2, 1980 Meeting

The meeting was called to order by President Baker. Secretary Williams was the only officer absent. Treasurer Funk gave the treasurer's report--at that time the society had a balance of \$1913.94 and a total active membership of 94.

President Baker then read letters from Don Hodel and Barbara Nobriga regarding ohia logging in South Kona. The letters are included elsewhere in the Newsletter. Also, President Baker requested a volunteer to collect biographical material on botanists in Hawaii for the Society's Newsletter.

Nominations for vice-president followed, with Paul Kores being unanimously nominated. In addition, Winona Char was named Plant of the Month Chairperson.

The speaker for June was Dr. John Hall of the Microbiology Dept. His talk was on his travels in Nepal, a presentation concluded by a graphic and now amusing account of how he was gored by a rhinoceros.

Respectfully submitted,
Julie Williams, Secretary

Minutes: October 6, 1980 Meeting

The meeting was called to order at 7:35 by President Baker. John Obata, Conservation Committee chairman gave an update on the activities of the committee. President Baker requested additional ambitious volunteers to join the existing committee.

Treasurer Funk reported a balance of \$2326.44 in the Society's checking account. Membership chairman Towata then gave his report--in October there were 113 paid-up members, 23 honorary members, and 19 unpaid memberships. Next month's meeting announcements will include final requests for dues.

The Newsletter is partly written. Volunteers are needed to submit articles and to work on the completion of the latest issue.

Dan Palmer gave an historical account of the Native Plant Committee. He announced plans to form a Western States Native Plants Group.

President Baker had further updates regarding the ohia logging proposal which has been drawn up by business to lease state land. The state land use is presently being negotiated. Until now only private and Bishop Estate land is being logged.

A biographer for the Newsletter was again requested by President Baker. No one volunteered.

The nominating committee for 1981 was announced. The members are: Dan Palmer, Chairman, Paul Kores and Beatrice Krauss. Bill Busch is auditor for this year.

November is plant donation month.

Winona Char gave the plant of the month talk on the Ewa Plains project.

Joan Canfield was the speaker of the month. Her topic was Palau and its vegetation.

Respectfully submitted,
Julie Williams, Secretary

Minutes: November 3, 1980 Meeting

President Baker called the meeting to order at 7:30. November was Plant Donation Month.

Dan Palmer reported on a visit to 1500 acres of native forest in Honomolina to be cut down for a macadamia nut plantation. He expressed hope that an environmental impact statement will be drawn up before the land is sold.

Wayne Gagne was named as the new Conservation Committee Chairman. He spoke on the variety of issues he saw as important for Botanical Society action, including opposition to the Tri-Fly Program which would endanger insect pollinators and the Nanewale Forest Reserve illegal bulldozing problem. The Tri-fly program aims to eradicate the Oriental and Mediterranean fruit flies as well as the melon fly from the Islands. The plan will in part involve the broadcasting of baited insecticides throughout the Islands. Dr. Gagne indicated that there was a high probability that such a program would also eradicate Hawaii's endemic picture-wing Drosophilas as well as other endemic insects. The Nanewale Forest is a lowland native forest in the Puna area which has been partially bulldozed for papaya farming. It appears that the state has not followed its own regulations for the use of conservation lands.

A motion was passed empowering the Conservation Committee to draft resolutions representing the Botanical Society, however, two members of the Executive Committee must approve any proposal before it is sent off.

The Nominating Committee report named the candidates for officers for 1981. They are: Ray Baker, President; Paul Kores, Vice-President; Derral Herbst, Treasurer; Julie Williams, Secretary, Ruth Gay and Evangeline Funk, Directors.

The plant of the month speaker was Heide Bornhorst. Her talk was on Longwood Gardens.

Dr. Charles Lamoureux was speaker of the month. His talk was entitled "From Aceh to Timor, plant hunting in Indonesia."

Respectfully submitted,
Julie Williams, Secretary

Minutes: December 1, 1980 Meeting

President Baker called the meeting to order at 7:30 p.m. There was no ~~Tresurer's report given.~~ The secretary presented the Annual Report of the events of 1980. The Conservation Committee reported on their activities during November including a letter to Charles Yasuda regarding

May 8, 1980

Dear Don,

Monday, 5 May, I read your letter concerning ohia logging on the Big Island to the Hawaiian Botanic Society. We postponed a show of support for it until we could get more information, such as: where the logging is occurring more exactly, map coordinates, tax map keys, etc.; what the forest looks like, i.e. is it virgin forest, second growth, or isolated trees in cow pasture; are we concerned only about ohia trees here or is the whole forest being destroyed; what is the future for this land; is the forest being clear-cut or selectively thinned?

We are with you in principle, but feel that to give our support as a Society we need to have some specifics. We are inquiring of such people as Dieter Mueller-Dombois, Andrew Berger, and others what they think, but without specific locations it is hard for them to give an opinion. Hopefully you will have your show of support at our June meeting.

Since you mention Donn Carlsmith by name I would like to approach him on it after I have more facts. Should I mention your name? Dr. Cliff Smith wants to publish your letter in the Hawaiian Botanical Society Newsletter. Any objections? Let me know soon.

Ray Baker, President
Hawaiian Botanical Society

May 27, 1980

Mr. Baker,

I have just spoken with Don Hodell on the logging situation on Hawaii. It is criminal.

I have witnessed the total devastation of the lands above Kukaiau in the Eucalyptus forest and the criminal destruction of the koa and ohia in Honomalino.

I even passed a logging truck today that could only carry three logs because they were too large for any more to fit on the truck. Two were an easy 3 feet across and one an easy 5 feet.

I have not been into the lands of Kapua to see what is going on but I constantly see the trucks going by loaded with those huge old ohia trees.

Bishop Estate is also guilty of this wanton destruction in their Keauhou Mauka lands. I have been all through that area too.

Certainly hope your organization has some clout.

Barbara Nobriga
Kealahou, HI

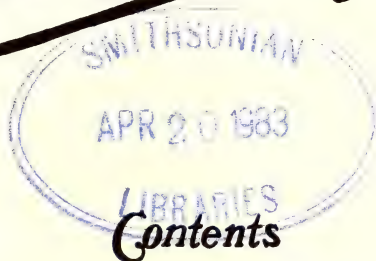
NEWSLETTER
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c/o BOTANY DEPARTMENT
UNIVERSITY OF HAWAII
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Hawaiian Botanical Society



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1981

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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

REPORT ON THE XIVth PACIFIC SCIENCE CONGRESS IN Khabarovsk,
U.S.S.R.

Dieter Mueller-Dombois
Department of Botany
University of Hawaii at Manoa
3190 Maile Way
Honolulu, HI 96822

The Congress took place from August 20 to September 2, 1979. Few participants took part in post-congress tours. Because of charter flight arrangements, I had to leave Hawaii already on August 16. This arrangement forced U.S. participants coming via Tokyo to stay in the expensive Intourist Hotel (about \$62.00/night without meals) already two days before the initial inauguration. However, apart of the extraordinary expense (the cost for hotel accommodation alone was over \$1,000 for only 16 days), the Khabarovsk Congress proved to be a worthwhile and stimulating experience.

Approximately 3000 scientists attended, 2200 from Russia and 800 from abroad. The Congress was inaugurated in the large "Palace of Sports" by Academician Sidorenko on August 20. The official languages were Russian and English and all plenary talks were transmitted by simultaneous translation.

The overall Congress theme was "Natural Resources of the Pacific Ocean—for the Benefit of Mankind." Congress sessions were organized under the names of the 14 scientific committees. This caused considerable overlap of topics in individual sessions and many of them lacked any sort of integrated structure. However, since 50% of the foreign participants in the program did not arrive (probably because of high expenses and visa problems), many sessions were combined. This had the advantage—at least in my area of involvement—that some sessions could be restructured in a more topic-integrated manner.

Because of my position as Chairman of the Scientific Committee on Conservation and Environmental Protection, I became involved in several last-minute reorganization problems. As a result, I presided over five different symposia. In my plenary talk on "Monitoring Island Ecosystems: An Approach for Conservation Purposes," I presented a program in four parts (with 12 project elements) which later was accepted for an enlarged future role of this particular Committee.

An enlarged role of the Committee on Conservation and Environmental Protection was decided during successive meetings of the Pacific Science Council and the Committee Chairmen. During these meetings the goals of the Pacific Science Association were reaffirmed as those of promoting science and scientific cooperation throughout the Pacific region. However, one important practical outcome of scientific work in the Pacific region besides that of supporting resources exploitation and technology is the issue of rational use, conservation management and protection of the natural resources of the Pacific region. The conservation theme has been an important tradition in the Pacific Science Association since the first Pacific Science Congress in Honolulu in 1920. Because this mission has

increased considerably over the last decade the conservation theme now needs to be approached in a more structured and better organized framework. It was decided, therefore, to substructure the Committee on Conservation and Environmental Protection into three subcommittees, one dealing with island ecosystems, one with marine ecosystems and one with the continental coastal zone ecosystems surrounding the Pacific.

The ecosystem orientation of the Conservation and Environmental Protection Committee provides for a new focus on interdisciplinary research. This focus will be an important complementation to the other scientific committees, which are largely organized along disciplinary lines, e.g. Geography, Entomology, Botany, Geology, etc. The four program areas for each subcommittee of the Conservation and Environmental Protection Committee emphasized were:

- A. Ecological Inventories and Comparisons
- B. Study of Dynamic Processes
- C. Methodology and Approaches
- D. Application and Conservation Action

Under B above, both natural and man-induced processes are of concern. Under C above, the concern is particularly with appropriate and comparable methods of ecosystem monitoring, including the use of biological indicators. Encompassed under D above are the important concerns with conservation education and the establishment of networks of biosphere and other ecological reserves within each of the three broad Pacific ecosystems.

My additional involvement was particularly in the group of scientists concerned with island ecosystems research and the MAB/7 project (UNESCO Man-and-the-Biosphere project on "Ecology and Rational Use of Island Ecosystems"). There was a workshop meeting in which reports on MAB/7 activity were given by country (Australia, England, N. Zealand, France, Philippines, Japan, U.S.S.R., Indonesia and U.S.A.). It became painfully clear that the U.S. so far has done the least under MAB/7, while France and Russia had done the most. The U.S.S.R. had sponsored a scientific expedition to the South Pacific Islands on its research vessel, the "Kallisto," which has brought forth a wealth of new information. This became evident from a number of Russian Kallisto-expedition reports, which were presented during the Congress.

There was a good spirit of cooperation and many additional discussions were held during the Congress, particularly among the island ecosystems researchers. A clear need was expressed for developing a network of island ecosystem programs and research teams under the MAB/7 label and for identifying linkages in form of individual ongoing island research projects.

A rich and colorful cultural program with concerts, folk dances and Russian music was offered to the Congress participants. In addition, several banquets, an excellent scientific exhibition and various scientific films provided for interesting and stimulating entertainment.

It became abundantly clear that our Russian hosts had made a most sincere effort in setting up an inspiring Congress. In spite of the high cost and initial organizational problems they definitely succeeded in communicating and stimulating science and scientific cooperation with the Pacific region.

Minutes: December 1, 1980 Meeting

President Baker called the meeting to order at 7:30 p.m. There was no Treasurer's report given. The secretary presented the Annual Report of the events of 1980. The Conservation Committee reported on their activities during November including a letter to Charles Yasuda regarding the Tri-Fly project, a conscious-raising letter to Governor Ariyoshi concerning the Banana Poka problem in Hawaii's forests, and a letter to State Forestry questioning the legality of bulldozing Hale Poa'a forest in the Nanewale Forest Reserve. Copies of these letters are included in this Newsletter. Conservation Committee chairman, Wayne Gagne, noted that Botanical Society action is also presently necessary in two additional conservation matters of botanical import: the extensive pig damage in lower Kipahulu Valley and the possible conversion of native forest in Honomalino to a macadamia nut orchard.

The pig damage in lower Kipahulu is a serious concern because this originally pristine area has deteriorated since the National Park Service took it over from the State and the Nature Conservancy. Some ambiguities in the Nature Conservancy report on the valley resulted in the National Park Service closing the valley to all persons other than those with a genuine need to access Kipahulu Valley. Since the pig problem was brought to their attention they have established a scientific evaluation of the problem. Members are advised to write the National Park Service concerning the need for an aggressive pig management program in Kipahulu Valley.

Election of officers took place in December. The Botanical Society officers for 1981 are: Ray Baker, President; Paul Kores, Vice-President; Derral Herbst, Treasurer; Julie Williams, Secretary; and Evangeline Funk and Ruth Gay, Directors.

The Plant of the Month presentation by Derral Herbst was an update of the endangered plant species program in Hawai'i.

Speaker of the Month was President Ray Baker. His topic was "Palms in Hawai'i."

Respectfully submitted,
Julie Williams, Secretary

RESEARCH ON ENDANGERED HAWAIIAN SPECIES AT THE HAWAII FIELD
RESEARCH CENTER, HAWAII

James K. Baker
U. S. National Park Service
Hawaii Volcanoes National Park
Hawaii 96718

In the Hawaiian Islands there are three Federal land agencies of the United States Government which are active in the fields of research on the rare and endangered Hawaiian biota and in species and habitat conservation. These three agencies are the National Park Service, U. S. Fish and Wildlife Service, and U. S. Forest Service. Of the three agencies, the National Park Service is the largest land holder in the islands. Protected on National Park lands are some of the best of the native habitats which remain in Hawaii.

The National Park Service, therefore, encourages research in the Hawaiian parks which will aid the Service in the proper management and conservation of its natural resources. To help in these objectives, the Hawaii Field Research Center was established in Hawaii Volcanoes National Park in the mid-1970's to provide needed office and work spaces for National Park Service research programs. More recently, in 1978, the other two Federal agencies also established office and work spaces at the Center. The purpose was to facilitate cooperation and coordination among the researchers and research programs of the three agencies, not only on National Park land, but in all natural resource management areas throughout Hawaii.

The Hawaii Field Research Center is located in a rain forest habitat at 1,200 m elevation, situated near the east rim of the crater of Kilauea Volcano. The average rainfall is about 250 cm, and the average temperature is about 15 Celsius. To the west and north of the Research Center are two other volcano peaks which reach to heights of more than 3,900 m, and which are snow covered during winter months. To the south, 32 km of the park lowlands border on the rocky shoreline of the Pacific Ocean. To the southwest is a desert area downwind of the Kilauea Volcano, made desolate by the effects of prevailing winds carrying volcanic fume and creating a rain shadow.

These variable settings, and diversity of habitats, within relatively short distances of the Center provide unique opportunities for research at the Hawaii Field Research Center in a variety of biological and geological fields. The one common goal of the three agencies at the Center is to help salvage what remains of native Hawaii.

Hawaii's unique biota evolved over millions of years in the absence of man and other terrestrial vertebrates. Approximately 90 percent of the nearly 2,000 native plant species are endemic, and there are equally high percentages of endemic species of animals such as insects, other invertebrates, and birds. Such high degrees of endemism in Hawaii are results of the extreme isolation of the islands--more than 4,000 km from the nearest continental mainland--and the relatively few pioneer species which reached Hawaii across such wide expanses of ocean.

Following the discovery and colonization of the Hawaiian Islands by Polynesians more than 1,000 years ago, alien influences began changing the landscape and the composition of the highly endemic biota. These changes were subtle at first, but they accelerated rapidly some 200 years ago upon arrival of Europeans in the islands. The changes caused by man and his introduced cultigens and domesticated animals were disastrous to the native biota and fragile ecosystems which were extremely sensitive to the pressures of alien intrusions.

Consequently, in only 200 years, more species of native Hawaiian plants and animals became extinct--and more are presently threatened with extinction--than in any other biological province on earth. For example, of the world's total number of extinct birds, 24 forms, or 16 percent, disappeared from Hawaii and another 30 forms are endangered. Of the nearly 2,000 species and varieties of native plants, about 250, or 13 percent, are believed to be extinct and about 900, or 47 percent, are considered endangered.

Much of the current research effort in Hawaii on endangered species is directed towards the avifauna. Diseases of birds, predation, status and distribution, life histories, and the reestablishment of extirpated species are subjects of study. Other major research is directed towards problems of the rare, native plants. These projects focus on disease, competition with non-native introductions, control of the non-native exotics, and propagation. Still other research is concerned with the ecological impact upon both plants and birds caused by non-native mammals such as rats and mongooses.

One of the bird studies being done by the National Park Service is an analysis of the decline and extinction factors of the endemic avifauna. This study entails a long, exhaustive, literature search through references published over the last 150 years, to try to determine the many probable causes. The causes for decline considered most probable are habitat alteration and destruction, consequent food depletion, competition with introduced birds, predation by non-native mammals, and disease. Part of this study has already resulted in the preparation of a comprehensive annotated bibliography of all the known references to Hawaiian birds, totaling more than 3,000 citations.

Because of the disease probability, the National Park Service started studies three years ago on avian malaria in endemic birds. The research has shown that avian malaria probably adversely affected populations of the native species following an introduction of mosquito vectors into Hawaii in the 1920's. The subsequent abundance of mosquitos throughout the islands caused a widespread decline in the avifauna which had no natural immunities to the disease, although there is evidence now that the native birds are building up resistance to malaria. An additional part of this study, in cooperation with personnel at the Bernice P. Bishop Museum in Honolulu, was to identify the ectoparasites of native birds, which is producing a long list of descriptions of new families, genera, and species of host-specific mites.

The U. S. Forest Service has been active in a study on the structure and composition of forest bird populations. Birds are captured, marked, released, and followed daily in small study plots of 16 ha. The results

of the study are revealing information on breeding biology, food habits, competition and interactions among species, and other daily activities. The study will help determine the habitat requirements of the various species being studied, as one portion of the effort to define areas of native forest containing critical habitat needs.

In addition to these studies in relatively small study plots on individual birds, the U. S. Fish and Wildlife Service is looking at bird populations, as a whole, from island to island. The primary objectives are to determine the size of the bird population, the present population distribution, and the location and vegetation components of critical habitat areas. With such information, it is hoped that the need for additional large areas of habitat to be set aside for natural preserves to help conserve the birds can be substantiated and justified. To date, more than 1,100 km of transects have been established in the islands, surveying about 250,000 ha of habitat. The findings relative to the numbers of birds have been good. No birds believed to be extinct have been rediscovered, but some species are more abundant, and more widely distributed, than previously thought.

Successful attempts are being made by the National Park Service to reintroduce nene, or Hawaiian geese, back into the lowlands of Hawaii Volcanoes National Park, below about 750 m elevation. Historically, Hawaiian geese, an endemic species, had nested in lowland areas of the park during winter rainy seasons when sprouting green grass provided suitable food for both adults and goslings. The adults and young then migrated upland above 2,000 m during the ensuing summer dry season when the lowland grasses withered. In summer, green grass and berries are readily abundant in the higher elevations. However, following the introductions of mammal predators, such as rats, cats, dogs, pigs, and mongooses, and of herbivorous animals such as goats, which destroyed the lowland grasses, the Hawaiian geese were forced to inhabit the higher slopes of the mountains throughout the year.

Through the winter months, the National Park Service keeps pinioned pairs of geese in lowland enclosures, which are predator free, on the premise that goslings will imprint to the area of their birth and will return to the lowlands to nest. In 1976, the first young adults returned to the lowland. Three of the four young nested successfully. Other young returned in 1977 and in 1978. It is hoped that, with the additional program of mammal control in the lowlands around nesting sites, the Hawaiian geese will eventually become re-established in their former habitat. A 10-year goat control program has already eliminated these animals from the lowlands where sizeable herds once grazed the grasses down to bare soil.

Another study by the National Park Service is concerned with the distribution, abundance, and food habits of a mongoose and three species of rats in park habitats from sea level to about tree line at 2,000 m elevation. It is being shown in Hawaii that rats and mongooses are predatory on native birds. Mongooses are especially predatory on ground-nesting species and rats on forest birds in trees. Rats also severely damage the trees by eating bark, buds, flowers, nectar, fruits, and seeds. By their attraction to nectar, fruits, and seeds, rats are also competing with native birds of like food habits. Rats may also be

occupying tree cavities for nesting sites and taking over existing bird nests for their own, in direct competition with certain cavity and other tree-nesting species.

One study on the flora of the park by the National Park Service is to investigate various chemical and biological control techniques useful in combating the rapid spread of a number of aggressive, non-native, plant invaders introduced by man. It is believed that one of the most serious management problems throughout the Hawaiian Islands is the rampant spread of weedy, noxious species which compete with native forms. Other studies are concerned with the effects of disease upon native plants, methods of propagation of rare species under greenhouse conditions, and maintaining viable populations in the wild in natural habitats.

In addition to research, other activities at the Hawaii Field Research Center include monthly seminars by Center personnel or visiting scientists. In August, 1976, the First Conference in Natural Sciences was held at the Center, which resulted in a gathering of more than 100 researchers from throughout the State of Hawaii and the presentation of 42 scientific papers. It was believed that such conferences at the Center would provide opportunities for scientists elsewhere in the islands to meet in one location for papers and discussions on topics of mutual interest. The First Conference was such a success it was decided that other conferences should be held every two years. Accordingly, the Second Conference was held in June, 1978, at which time the Hawaii Field Research Center was officially dedicated. More than 150 scientists attended the Second Conference, with 52 papers presented. The Third Conference in Natural Sciences is planned for June, 1980.

The Research Center also maintains reference collections of plants, mammals, birds, and insects. A greenhouse with more than 300 sq. meters of work space, equipped with soil sterilizers, humidity and temperature control systems, and drip and mist apparatus for watering plants, provides facilities for both research and management needs. Rare plants are propagated and studied in the greenhouse and seedlings of common tree species are grown for reforestation projects.

An aviary is the most recent addition to the facilities at the Center, presently housing a number of the birds being used in the avian malaria studies. The nearly 100 sq. meter aviary consists of five separate compartments, each of which is mosquito proofed and contains its own feeding and watering facilities.

There are dormitory and work spaces available at the Research Center for visiting students and others who may wish to study and work in the area on natural history research. The larger two of four dormitories contain 20 bunks each, with an adjoining kitchen and a dining room which also serves as a classroom. Group use of these facilities is often made by various Hawaii and mainland United States universities and other institutions for student field trips and seminars.

Situated and equipped as it is, the Center provides an ideal setting for field stations of the three Federal agencies which, as this paper outlines, are actively involved in vital research on the endangered biota of the Hawaiian Islands.

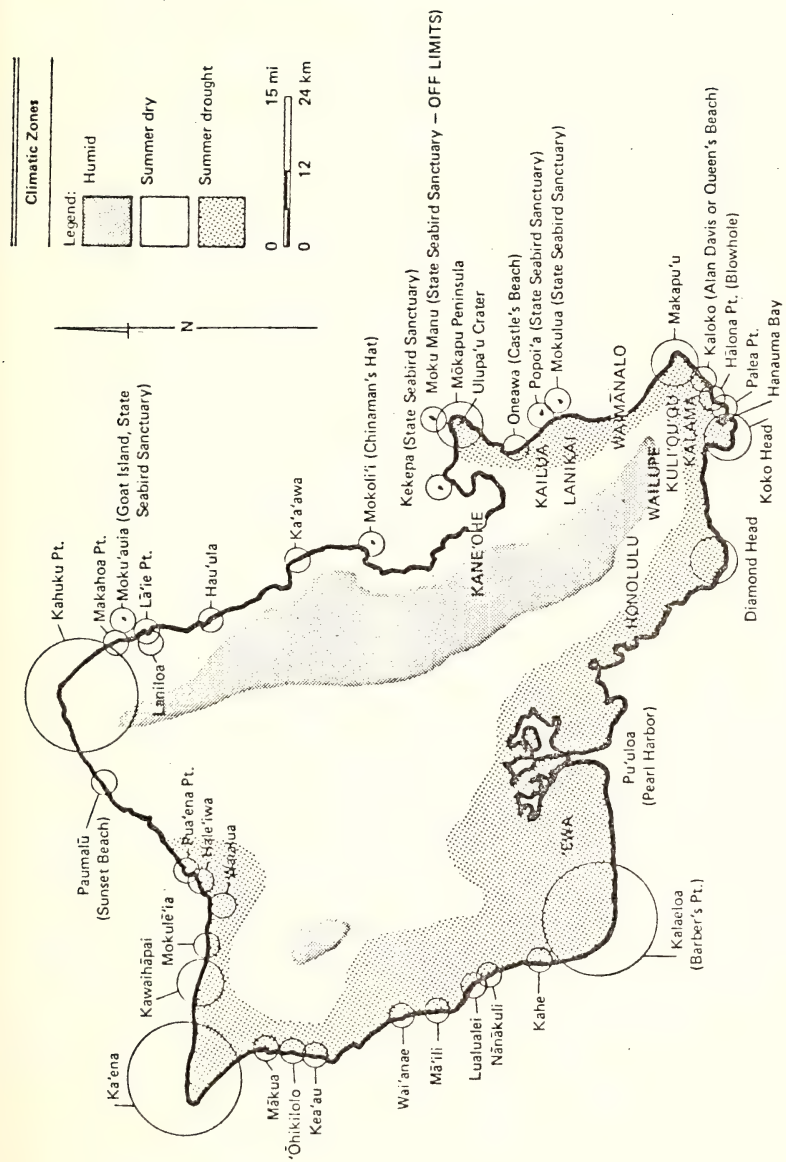


Figure 1. Generalized climatic zones of O'ahu and localities noted in text. (Adapted from Char and Balakrishnan, 1979)

Figure 1 was inadvertently omitted from the Hawaiian Botanical Society Newsletter Volume 19, 1981. Please insert this map on page 5.

May 28, 1980

Dear Ray,

In response to your recent letter requesting additional information concerning the logging of koa and ohia in Kona:

Barbara Nobriga of Kealakekua, Kona, who has seen first hand the destruction of the koa forest on Dillingham-Donn Carlsmith land in Papa, S. Kona, has told me that she will write you and the Hawaiian Botanical Society personally about what she observed.

I have been able to gather the following information from George Schattauer of S. Kona:

Koa logging—Lands of Papa, 4000 feet elevation on up; 500+ acres of virgin koa forest has been logged and destroyed; this logging is on Dillingham-Donn Carlsmith land; this is the same area that Barbara Nobriga will write to you about.

Ohia logging—Lands of Kapua, 2500 feet elevation on up, over 4000 acres involved, logging big trees not dead, hollow, or small trees; the remaining vegetation will be bulldozed for pasture land; although only big trees are being logged, the understory is being destroyed; this land was owned by Mac Nut Farms of Hawaii but may be owned now by a Mr. Driscoll. Lands of Keauhou, on Bishop Estate land; I do not know the elevation or acreage involved. I do know that the forest is being destroyed.

Ray, what is disturbing, also, is that Capitol Chips, the company logging the ohia, has applied to the State to log up to 10,000 acres of virgin ohia forest on State land! These areas include lands of Kaulanamauna, Manuka, and Honomalino. The ohia forest in the lands of Manuka is actually in State Forest Reserve but Capitol Chips still applied to log it!!! The ohia forest in the lands of Honomalino is probably the best example of virgin ohia forest left in Kona if not Hawaii. There in Honomalino is the largest remaining sandalwood, the rare Neowawraea (Drypetes), olopua, and the rare elements of this rich forest that Dr. Rock brought so much attention to. George has recommended to the Outdoor Circle in Kona that the entire areas of State land in Manuka, Honomalino and Kaulanamauna be made State Forest Wilderness Area to protect it. George told me the Maurice Sullivan of Foodland Stores is trying to lease the State land in Honomalino to clear it after it is logged for pasture.

I hope that this is of some help to you. Let me know if I can help anymore. I hope that something can be done.

Don Hodel
Kealakekua, HI

ANNUAL REPORT OF THE SECRETARY - 1980

This year, 1980, marked the 56th year for the Hawaiian Botanical Society. The officers for 1980 were:

President -	Evangeline Funk until 5/80 Ray Baker
Vice-President -	Ray Baker until 5/80 Paul Kores
Treasurer -	Lowell Funk
Secretary -	Julia Williams
Directors -	Keith Woolliams Nadarajah Balakrishnan

This year was notable for the successful membership dues drive headed by Mark Towata, Membership Chairman. Paid up members for 1980 rose from 94 to 113 during the year. There was also a favorable response regarding back payment. The success of this drive resulted in an increase in the Society's savings account. The treasurer's report for October gave the Society's bank balance as \$2326.34.

One newsletter was produced during 1980; the May/December 1978 edition.

In conservation matters, the society was active in supporting Wayne Gagne's proposal for a goat fencing and eradication program in Haleakala National Park. Information was gathered regarding the ohia logging operations in South Kona. No action was taken by the Society since all logging until now has been done on private land. A new Conservation Committee was formed in 1980 consisting of Wayne Gagne, Chairman, Anne Marie La Rosa, Joan Canfield, Steve Montgomery, and Rick Warshauer. In the November meeting it was decided by the Society's membership that all proposals drafted by the Conservation Committee would be read by at least two members of the Executive Committee before being submitted as representative statements of the Hawaiian Botanical Society. Thus far the Committee has represented the Society in opposing the proposed Tri-Fly program.

During the year the Society contributed \$50.00 to the funding of a poster in observance of National Wildlife Week in Hawai'i. The Society also awarded copies of Rock's "Indigenous Trees of the Hawaiian Islands" to the two Science Fair winners. The books were donated by the Pacific Tropical Botanical Garden. April and November were Plant Donation months.

The speakers for the past year were:

January -	Dr. Helen Kennedy (U. of Manitoba): "Marantaceae: pollination studies and a look at some cultivated species"
February -	Dr. Lyndon Wester (U.H. Geography Dept): "Invasion of Hawaii by exotic plants since Captain Cook"
March -	Dr. Peter Raven (Missouri Botanical Garden): "Tropical Conservation: a worldwide perspective"

- April - Dr. Cliff Smith (U.H. Dept. of Botany): "Resource management in Haleakala National Park"
- May - Paul Weissich (Honolulu Botanical Garden):, Bob Hirano (Lyon Arboretum), and Keith Woolliams (Waimea Arboretum): "The role of the botanical garden in Hawai'i"
- June - Dr. John Hall (Dept. of Microbiology): "Travels in Nepal"
- July to September was the Summer break.
- October - Joan Canfield (U.H. Dept. of Botany Graduate Student): "The vegetation of Palau"
- November - Dr. Charles Lamoureux (U. H. Dept. of Botany): "From Aceh to Timor, plant hunting in Indonesia"
- December - The presidential address by Ray Baker: "Palms in Hawai'i."

Respectfully submitted,
Julia Williams, Secretary

Minutes: January 5, 1981 Meeting

President Baker called the meeting to order at 7:30. The auditor's report was given by Mr. Bush. His report showed all Botanical Society accounts to have increased for 1980 over 1979.

There was no Conservation Committee report during January, nor was there a Native Plants report. President Baker announced that a request by the Conservation Committee for a yearly budget of \$180.00 had been approved by the Executive Committee.

There was a call for volunteers to act as judges in the upcoming Hawaiian Science and Engineering Fair to be held in February.

February will be plant exchange month.

Dr. Bates from Cornell was Speaker of the Month. His topic was "Hunter-Gathers: The Origin of Agriculture."

Respectfully submitted,
Julia Williams, Secretary

PLAUDIT FOR DR. OTTO DEGENER

The following resolution (SR#294) was adopted by the Tenth Legislature of the State of Hawaii commending Dr. Otto Degener.

WHEREAS, the flora and fauna of Hawaii's unique island ecosystem are a most treasured resource; and

WHEREAS, the preservation of our wildlife resources, which have adapted and evolved in our isolated oceanic environment over many thousands of years, has become a paramount concern in the recent years of Hawaii's rapid urbanization; and

WHEREAS, Dr. Otto Degener, botanist, taxonomist, conservationist, author, and advocate, has devoted well over a half-century toward a better understanding of our invaluable yet highly sensitive natural environment; and

WHEREAS, Dr. Degener's many works, including Plants of Hawaii National Park and the seven-volume Flora Hawaiiensis, comprise an unparalleled collection of information on plant-life in Hawaii, and stand as a remarkable resource in itself to students, teachers, scientists, and laymen alike, both locally and worldwide; and

WHEREAS, Dr. Degener has been an inspiration to countless others in teaching the values of native ecosystems, in encouraging study of Hawaiian plants, and in recruiting new workers for protection of native wildlife and plants; and

WHEREAS, Dr. Degener stood alone for most of the past fifty years as a voice in the wilderness, steadily appealing year after year for recognition of Hawaii's botanical wonders and conservation of their habitats, having no peer in his unshakeable, deep commitment to Hawaii's natural environment; and

WHEREAS, Dr. Degener has been tireless in his forthright, fearless efforts to educate and influence government officials, developers, journalists, other conservationists, and the general public to seek protection of native habitats from the bulldozer, feral mammals, introduced game, and introduced weeds that naturalize in our native forests; and

WHEREAS, Dr. Degener has influenced and inspired many people in Hawaii and throughout the world with his deep love of fauna, flora, and the land which is Hawaii; and

WHEREAS, all of us who care about the natural beauty and special qualities of these islands that set Hawaii apart in the work of nature, owe a bottom-line debt of gratitude to Dr. Degener for his lifetime perseverance in relating humankind to the natural environment upon which we ultimately depend for survival as a species; and

WHEREAS, Dr. Degener, who will be eighty this year, continues to demonstrate his remarkable stamina, good humor, and zest to get on with research and writing projects—and initiate new ones; and

WHEREAS, this outstanding service of Dr. Otto Degener in fostering the preservation of our community's precious wildlife resources is worthy of our recognition and commendation; and

WHEREAS, it is particularly fitting that his five and one-half decades of generous service to Hawaii be extolled by the State Legislature; now, therefore,

BE IT RESOLVED by the Senate of the Tenth Legislature of the State of Hawaii, Regular Session of 1979, that it commend Dr. Otto Degener for his contribution to the preservation and enhancement of Hawaii's wildlife resources; and

BE IT FURTHER RESOLVED that a certified copy of this Resolution be transmitted to Dr. Degener.

Minutes: February 2, 1981 Meeting

The meeting was called to order by President Baker. Derral Herbst gave the Treasurer's report. Members were reminded by Membership Chairman Mark Towata to begin paying their 1981 dues. Students \$4.00, all others \$7.50. The Native Plants committee report was given by Dan Palmer, Chairman. A priority list of the next 20 proposed endangered species was recently prepared by the committee. Dan also reported on the apparent illegal bulldozing by State Forestry at Puu Kapele Forest Reserve, Kauai. Slides were presented showing the extensive destruction to the area—a predominantly native forest of Koa and 'Ohi'a. A request was made by Dan that the Botanical Society set aside monies from the Marie Neal Fund to aid in legal action against such environmental degradation. A proposal to set aside \$2,000 from the fund for this purpose was approved. The money would be held in the Fund and be distributed as needed by the Trustees to the Chairman of the Conservation Committee.

In other business, Debbie Ward and Marjorie Whiting have volunteered to represent the Botanical Society as judges in the upcoming high school Science Fair. PTBG has donated two copies of Rock's "Indigenous Trees of the Hawaiian Islands" as prizes.

Steve Montgomery of the Conservation Council for Hawaii requested a \$100 donation from the Botanical Society for educational materials to be distributed in the State's schools during Wildlife Week this month. His request was approved.

Plant of the month speaker was Carolyn Corn. Her topic was the endangered plants of Kahoolawe.

Speaker of the month was Al Samuelson of Bishop Museum. He spoke on his travels through the New Hebrides.

Respectfully submitted,
Julie Williams, Secretary

PALAU: DIVERSITY AND STATUS OF THE NATIVE VEGETATION
OF A UNIQUE PACIFIC ISLAND ECOSYSTEM

Joan E. Canfield
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University of Hawaii at Manoa
Honolulu, Hawaii 96822

INTRODUCTION

The Palau island group lies at the western border of both the Caroline Islands and Micronesia in the western Pacific. From 1977 to 1979, I was engaged as a botanist in Palau by the Peace Corps/Smithsonian Environmental Program. I worked at the Office of the Chief Conservationist of the Trust Territory of the Pacific Islands. My collecting trips throughout the district of Palau enabled me to provide this overview of the vegetation types of Palau, and a few words about the uniqueness of that small corner of the Pacific.

SETTING

The Palau island group is located roughly 500 miles east of the Philippines, north of New Guinea, and southwest of Guam (Fig. 1). It is made up of over 300 individual islands, most of them within a huge barrier reef that stretches 70 by 20 miles. The total land area of Palau District is 188 square miles, the size of Lana'i and Kaho'olawe put together. Palau covers just one-half of the land area of Hawai'i Volcanoes National Park.

Palau is occupied by some 15,000 people, whose ancestors migrated on many successive occasions from the Philippines, Indonesia, and Melanesia, beginning about 1500 B.C. The island group has been subjected to Spanish, German, Japanese, and American administration over the past 100 years. The 37-year long U. S.-administered U. N. Trusteeship ended January 1, 1981. With the creation of the Republic of Belau, Palau has become an independent nation.

Palau is barely seven minutes north of the Equator. Its climate is hot and damp: average temperature throughout the year is 80°F and the relative humidity is 80%, with an annual rainfall of about 150 inches. Northeast trade winds prevail throughout the winter months, and typhoons are infrequent.

Palau's flora is richer than that of any other district of Micronesia, in part because of its greater proximity to Asia, which has increased the probability of dispersal of taxa from Asia to Palau. At the same time, the isolation of the 330 islands of Palau from surrounding island groups has helped give rise to a large number of endemic species. In addition, a wide variety of substrates and habitats has made it possible for more immigrant taxa to persist on Palau.

The diversity of landforms and substrates in Palau is especially remarkable for such a small Pacific island group. The largest island in Palau, Babeldaob, is of ancient volcanic origin, today reaching only a

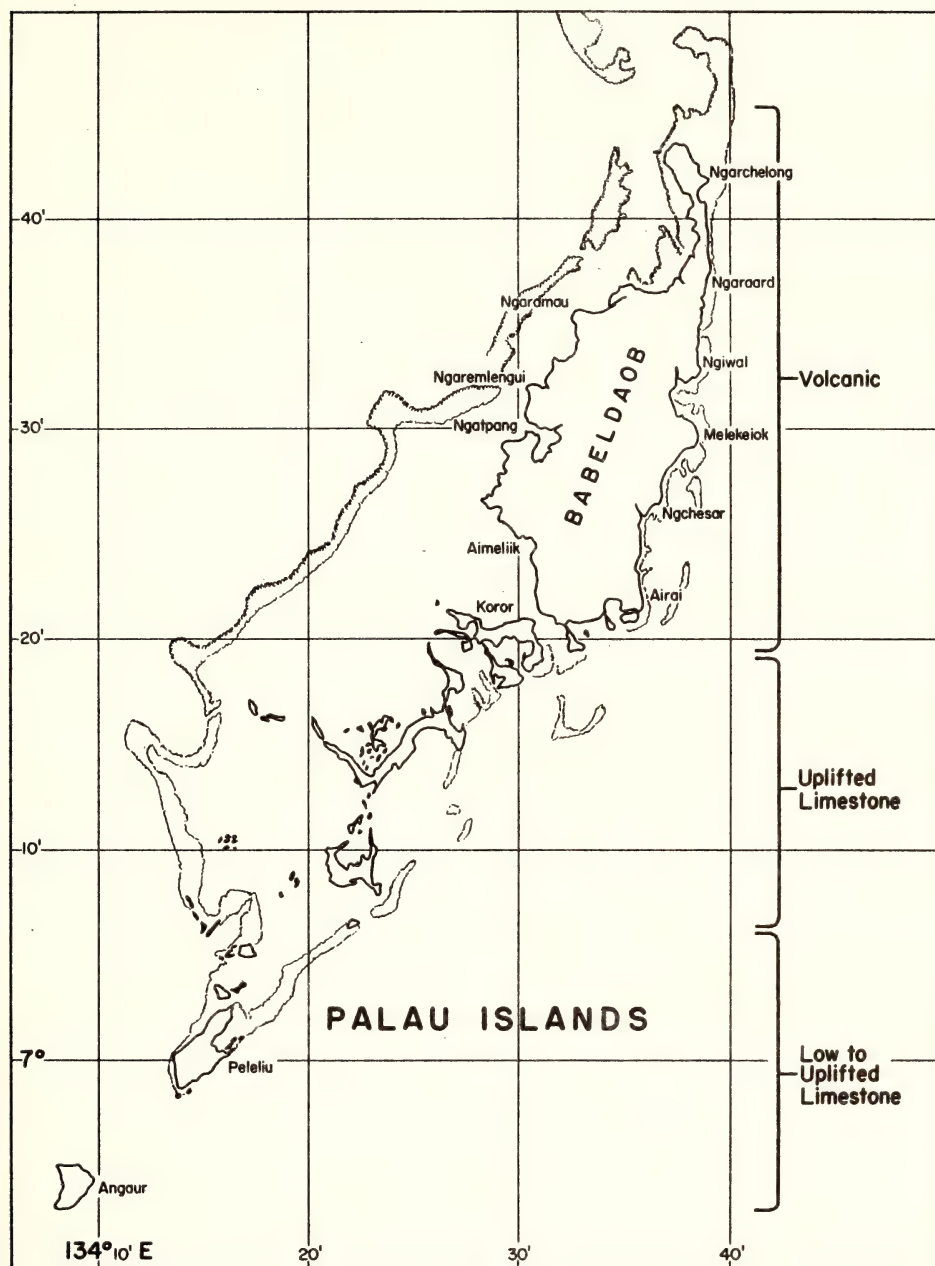


FIGURE 1. Map of the Palau Island group.

moderate elevation of 240 m (790 ft). Nearly all of the other islands of Palau are of coral limestone rather than of volcanic origin. Koror Island, the district center, is both volcanic and limestone. In Palau, some ancient reefs have been uplifted into raised limestone islands, up to 220 m (720 ft) in elevation, as well as into classic low coral atolls.

VEGETATION TYPES

I will briefly describe eight very broad vegetation associations characteristic of the substrates just mentioned. These vegetation types follow those of Fosberg (1960).

Strand

The strand association should appear familiar to Hawaiian residents. Most strand plants are easily dispersed by ocean currents, so that most of Hawai'i's strand species also grow in Palau. Strand communities are found on the atolls of Palau, the low coral islands, and on the east coast of the big volcanic island, Babeldaob, inside the fringing reef. Strand species common to both Hawai'i and Palau include kou (Cordia subcordata Lam.), the tree heliotrope (Messerschmidia argentea (L. f.) Johnston), and naupaka-kahakai (Scaevola taccada (Gaertn.) Roxb.).

The strand communities of Palau do not appear to be as extensive or diverse as those of Hawai'i, perhaps because the protected coastline inside Palau's barrier reef allows a richer forest community to take over much of the strand habitat.

Low Coral Island Forest

The influence of man is immediately obvious in this vegetation type, many of the species being economically valuable ones. In Palau, as in Hawai'i, Casuarina, coconut (Cocos nucifera L.), hau (Hibiscus tiliaceus L.), and Pandanus appear in low coral island vegetation, as well as breadfruit (Artocarpus), arrowroot (Tacca leontopetaloides (L.) O. Ktze.), and others.

Mangrove

There are half a dozen major mangrove species in Palau, forming a broad zone along the west coast of Babeldaob, up the river channels of that island, at the margin of a few low coral islands, and bordering the intriguing marine lakes found in some raised limestone islands (these marine lakes are landlocked except for underwater channels linking them to the lagoon waters).

The aerial roots of mangroves enable the trees to absorb oxygen, which is lacking in the thick mud washed down to the mangrove swamp from the island interior. Mangrove species are easily identified by aerial root characteristics. Also, mangroves usually are found in distinct zones mauka from the lagoon. Nearest the sea grow Sonneratia alba J. E. Sm. and two species of Rhizophora (R. apiculata Bl. and R. mucronata Lam.). Sonneratia's aerial roots are slender and erect, while Rhizophora has interlocking proproots which grow from high on the trunk.

Further inland, in less saline water, is Bruguiera gymnorhiza (L.) Lam., with looped aerial roots. The Nypa palm (Nypa fruticans Wurm.) is another member of the mangrove formation; it is easily recognized by its distinctive odor, reminiscent of dead crocodile. In fact, crocodiles are all too common along Palau's mangrove channels.

Ecologically, mangroves are very important, trapping the rich sediment runoff from the volcanic islands. Logging of these mangrove forests could lead to serious siltation at the reef edge, which would not only waste valuable fertile soil but also kill reef organisms.

Coastal Plain

The coastal plain vegetation type shows perhaps the greatest influence of man. The rich agricultural land, gentle topography, and ready access to the lagoon waters have made the coastal area the prime site of Palauan habitation. What once were dense forests have been cut over and replaced with tapioca and sweet potato fields, taro swamps, and agriforests, made up of a combination of native and introduced species of economic value. Most of the introduced plants of the coastal plain are used throughout Polynesia: coconut, mango (Mangifera indica L.), guava (Psidium quajava L.), various citrus species, over 10 varieties of banana (Musa spp.), papaya (Carica papaya L.), and useful ornamentals, such as ti (Cordyline terminalis (L.) Kunth), hibiscus, and many more.

While the utilization of the coastal lowland has probably restricted the distribution of some native species, the managed agriforests seem to make up a fairly well-balanced ecological unit.

Lower Primary Forest

Little remains of the primary forest of the lower slopes of Palau's volcanic islands. However, reasonably mature forest can still be found on the west coast of Babeldaob. These areas are prime examples of tropical oceanic island jungle: the massive trees are hung with thick lianas, their trunks carpeted with mosses, branches trailing great curtains of ferns and orchids. The community structure of these forests has not been studied, but they appear to be quite rich in numbers of species.

Secondary Forest Slopes

Here the original forest was once cleared for agricultural use. Common crops are coconut, dryland taro (Colocasia esculenta (L.) Schott.), and tapioca (Manihot esculenta Crantz). Much of this farmland has been abandoned, however. Secondary succession has followed, through grass and scrubland to a fairly dense secondary forest. The Palau tree fern (Cyathea lunulata (Forst. f.) Copel.) is a common dominant, as is Senecarpus venenosus Volk., an especially toxic relative of poison ivy. Here, too, is Ixora casei Hance ex Walp., grown ornamentally in Hawai'i.

Savanna

The rolling hilltops of most volcanic islands in Palau are covered with a savanna vegetation of scattered shrubs, grasses, and uluhe (Dicranopteris linearis (Burm.) Underwood), rather than forest. These

upland savannas may be natural, lacking forest because of the nutrient-poor clay soil, which the Japanese were able to mine for bauxite. It is fairly certain, however, that the savannas are now much more extensive because of the influence of fire. The Palauans traditionally set fire to these hills to clear the land for farming. Today fires are set to clear paths for pigeon and fruit bat hunters, or else just for sport.

Recurrent fire has changed the savanna substrate and vegetation. Topsoil washes away following fire, and regeneration of fire-resistant plants is favored. As in Hawai'i, the fire-favored grasses and uluhe burn readily. Subsequent fires then destroy a larger savanna area, burning on into the forested ravines. Eventually, the savanna slopes are reduced to eroded clay canyons, supporting little vegetation and of no use as farm or pasture land.

While the end result of savannas burned repeatedly is economically useless land, the less severely burned savanna vegetation is quite appealing. The rolling hills are covered with clubmoss (Lycopodium cernuum L.); dotted with shrubs, ground orchids (Spathoglottis), and occasional Pandanus trees - a welcome relief from the thick tropical forest. The successional pattern in these areas is especially intriguing, but as yet uninvestigated.

Raised Limestone Islands

The islands of southern Palau, typically, are extremely steep, up to 220 m (720 ft) in elevation, and undercut by a combination of wave action and the activity of marine invertebrates. The loose limestone substrate is quite dissected and eroded by rain water, and treacherous for human limbs. Virtually no ecological work has been carried out on these limestone islands. The vegetation is quite distinct from forests on volcanic substrates, and can be divided into four basic types: cliff, ridgetop, slope, and depressions and marine lake margins.

The cliffs support a community similar to the strand or back of strand vegetation in Palau: Casuarina and Pandanus are common, as is Dracaena. An endemic member of the Rubiaceae, Bikkia palauensis Val., is probably the showiest cliff-dweller.

The ridgetop vegetation of these limestone islands was formerly dominated by several native palm species, two of them endemic (Gulubia palauensis (Becc.) Moore & Fosb. and Ptychosperma palauensis (Kaneh.) Moore & Fosb.). Unfortunately, the introduced sulphur-crested cockatoo (Cacatua galerita (Latham)) and eclectus parrot (Eclectus roratus (P. L. S. Müller)) are killing these palms by eating the terminal buds. The native palms have been declared endangered and are already very rare in the upper canopy level of all but the most isolated limestone islands.

The slopes of the limestone islands typically lack a humus layer, yet they are extremely densely vegetated. Common members of this diverse assemblage are Elaeocarpus, Intsia bijuga (Colebr.) O. Ktze., numerous ferns, and endemic orchids.

Depressions and marine lake margins host yet another vegetation type, also rich in ferns and herbaceous species.

In addition to the steep limestone islands, there are two larger, but less precipitous raised limestone islands in Palau. Peleliu and Angaur were the sites of phosphate mining and heavy wartime activity, which decimated much of the original vegetation. The scrub forest that has grown up out of the bombed and bulldozed rubble of the mid-1940's is distinctive. Oddly enough, it supports at least one apparently endemic species, Maesa canfieldiae Fosb. & Sachet (Myrsinaceae). This plant may yet prove to be a weedy wartime introduction. Much of the flora of Peleliu and Angaur is weedy. Hawaiian residents would recognize Ipomoea species, Lantana, and Operculina as familiar pests.

FLORA OF PALAU

Some statistics on the flora of Palau are provided in Table 1. These numbers are highly preliminary in nature, based on a checklist that I helped Dr. F. R. Fosberg of the Smithsonian Institution to compile (Fosberg et al. 1980). Families with the greatest representation of native taxa in the Palau flora are the orchid and sedge families and the Rubiaceae. Altogether 1258 taxa, including varieties, have been found on Palau's 188 square miles. A full two-thirds of those taxa are native. The native plants represent over 400 genera.

Palau boasts about 65 endemic species, and 10 endemic varieties of plants. This means that over 9% of the taxa native to Palau are endemic. That percentage pales by comparison with the 97.5% level of endemism given for Hawai'i by St. John (1973). However, considering the size of Palau in relation to Hawai'i - just 3% of Hawai'i's total land area - and Palau's proximity to a continental landmass, the figure for Palauan endemics is quite impressive.

The significant contribution of diversity in substrate and habitat to the floral richness of Palau has already been noted. A wide variety of niches must have been available to immigrant plants on this unusual combination of low and uplifted limestone and basalt. This diversity has permitted the differentiation and survival of Palauan endemics.

HUMAN DISTURBANCE

Several disturbance factors that have taken a toll on Palau's native vegetation have been mentioned. These include the historical burning of uplands, extensive cultivation of lowlands, mining and war damage, and the recent influx of weedy introductions, especially since World War II.

As in Hawai'i, development proposals threaten the native flora and fauna of Palau. The most disturbing of these is an oil supertanker port proposal, which has been defeated for the present. The possibility of devastation to Palau's extensive reef communities should discourage further consideration of this plan.

It appears that feral herbivores are not nearly so destructive in these islands as they are in Hawai'i. These introduced species cause only limited damage, most of it to crops, rather than to native vegetation. Feral pigs are hunted down to very low concentrations and the feral goat population totals no more than perhaps twenty head.

PROGNOSIS

Just as in Hawai'i, little progress has been made in Palau toward setting aside natural areas for preservation. The Seventy Islands Nature Reserve is one exception. A natural advantage for much of the native vegetation of Palau is its inaccessibility and relative inhospitality to the human species. The craggy, chigger-infested, poison tree-filled high limestone islands are destined to remain fairly pristine.

Aside from this natural protection, a conscious effort toward preservation of the native environment is underway. The native people are beginning to revive their traditional conservation ethic and affirm the value of the quite unique natural environment of their homeland.

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TABLE 1. Preliminary survey of the vascular flora of Palau.

	<u>Native</u>		<u>Exotic</u>		<u>Native & Exotic*</u>		<u>Total</u>
	#	%	#	%	#	%	
Families	53	37	26	18	64	45	143
Genera	54	8	230	35	369	57	653
Species	797	66	418	34	---	---	1215
Varieties & Subspecies	33	77	10	23	---	---	43
TOTAL TAXA	830	66	428	34	---	---	1258

*Some taxa within the designated category are native; others are exotic.

Nov. 29, 1978
P.O. Box #124
Kailua-Kona, HI 96740

Editor, Hawaiian Botanical Soc. Newsletter
c/o Dept. of Botany
Univ. of Hawaii
3190 Maile Way
Honolulu, HI 96822

Dear Editor:

It may prove of interest to some members of the Botanical Society to know that Delissia undulata* is almost extinct on this island. According to J. F. Rock, Indigenous Trees, p. 45, he states, "The plants are extremely numerous." According to Mr. Nicholas J. Mitchell of Kealakekua, Hawaii, whose family owns the Pu'u Lehua Ranch, there are only 4 plants left and only 2 of these appear to be in good health. The Pu'u Lehua Cone is located in the Bishop Estate land of Keauhou 2, N. Kona, Hawai'i, at an elevation of about 5000 ft. Although the Bishop Estate fenced the rim of this crater a few years ago no natural seedlings have been noted. Perhaps this is due to the heavy growth of Kikuyu grass in this area.

Mr. Mitchell was fortunate to find mature seeds on the two healthy plants which he gave to me and which I forwarded to the Lyon Arboretum. I understand that they are attempting to germinate them and if successful, seedling plants should be available for out planting.

Rock also found this plant at Pu'u Wa'awa'a at a lower elevation. I have never been able to locate it there.

I hope that the seedling made possible by Mitchell's action may increase the numbers of this rare plant. Grazing animals have no doubt contributed to its demise. Perhaps others will take an interest to plant seedlings in suitable areas.

Sincerely,
L. W. Bryan
Forester

* St. John in his 1973 List of the Flowering Plants in Hawaii notes that this species should be called Delissea argutidentata E. Wimm. and that it is endemic to the Big Island.

Minutes: March 2, 1981 Meeting

The meeting was called to order by President Baker. The treasurer's report was given by Derral Herbst. The Society's checking account balance for February was \$1844.45.

Wayne Gagne presented the Conservation Committee's report. A meeting was held in February between representatives from the Botanical Society, Audubon Society and State Forester, Liebert Landgraf regarding the future of illegal cutting of native forest areas.

A hearing was scheduled for March 13 to discuss whether an environmental impact statement will be required for the proposed conversion of 900 acres in Honomolino Forest to a Macadamia nut orchard.

Wayne also reported that hunting groups have agreed to eradicate all sheep and goats from Mauna Kea in compliance with the ruling against the state's sustained-yield hunting program on Mauna Kea. The mouflon sheep was not affected by the ruling. Several members expressed concern that as long as any exotic herbivores were left on the mountain the mamane-naio forest was threatened.

Dan Palmer gave the Native Plants Committee report. The committee, along with the Society for Evolutionary Biology, is compiling information regarding native ecosystems' economic value in an effort to demonstrate the greater dollar value of a native forest over one converted for commercial forestry.

Carolyn Corn announced that the Smithsonian is soliciting pictures of endangered and rare plants from Hawaii.

President Baker presented Kirk Apt with the Outstanding Botany Student award for 1980.

Plant of the Month Speaker was Dan Palmer who spoke on Remya mauiensis.

Speaker of the Month was Sy Sohmer. His topic was the flora of the Ceylon Project.

Respectfully submitted,
Julie Williams, Secretary

Minutes: April 6, 1981 Meeting

President Baker called the meeting to order. The treasurer's report was given by Derral Herbst. Paul Kores, representing the Conservation Committee, gave an update on the Kauai bulldozing situation. A letter was sent to the lawyer representing the Audubon Society and Conservation Council by the State Forester. The letter stated that State Forestry was in agreement with the terms set forth by the lawyer regarding future bulldozing on State land. However, the letter was not very specific nor were the terms agreed to officially stated.

Dan Palmer reported on his and Dr. Lamoureux's trip to Auahi on Maui. Due to past and ongoing cattle destruction the area has very little regeneration of native trees. The forest is rapidly declining. The membership discussed ideas to monitor the disturbed area.

In other business, Milton Manhoff expressed concern over the Botanical Society's decrease in participation in the State Science Fair. A motion was passed to establish a travelling trophy which would be presented to the school of the first prize winner in the botanical sciences division.

Various announcements were made regarding meetings, hearings and a television program of interest to conservationists, all to take place in April. May was announced as plant exchange month.

Plant of the month speaker was Sheila Conant. The plants of Nihoa Island were presented.

Speaker of the month was Hardy Spoehr. His topic was The Nature Conservancy in Hawaii.

Respectfully submitted,
Julie Williams, Secretary

Minutes: May 4, 1981 Meeting

President Baker called the meeting to order. The treasurer's report was given by Derral Herbst. Wayne Gagne then presented the Conservation Committee report. Regarding Lapa Ridge on Kauai: Lawyer Ken Kupchek has sent a letter to Liebert Landgraf reminding him of his agreement to abide by state regulations as they apply to future tree planting programs on state lands. Wayne also reported the state's unwillingness to support the nomination of additional endangered species--one example, Panicum carteri, is found only on Chinaman's Hat. The state were the only people opposed to the nomination of this plant.

President Baker asked for volunteers to work on the upcoming Newsletter which will be published by September.

The membership approved a \$100 donation to the Waimea Arboretum Foundation.

Steve Montgomery presented a letter he wrote Mayor Tavares of Maui commending him and the Maui County Council on their concern for native flora as demonstrated in the Maui Zoological and Botanical Garden. The membership approved the gesture.

May was plant donation month.

There was no plant of the month speaker for May. Speaker of the Month was Sheila Conant. Her topic was "The Flora and Fauna of Nihoa Island."

Respectfully submitted,
Julia Williams, Secretary

Minutes: June 1, 1981 Meeting

President Baker called the meeting to order.

Conservation Committee report:

Liebert Landgraf has sent a reply to Attorney Kupchek's letter. No fee has been asked by Kupchek thus far.

Sen. Inouye has met with conservation groups regarding goat eradication. He regards goat removal from Haleakala as top priority. He also will try to pressure the Navy into removing goats from Kaho'olawe. A public meeting on the Hawaii Wildlife plan suggests that goats should be removed from Lana'i, Kaho'olawe and Oahu (?).

Six state natural areas are presently under consideration.

There was a call for Newsletter volunteers to help get it published by September.

President Baker read the letter from Mayor Tavares thanking the Botanical Society for the resolution commending them for their interest in native flora.

Milton Manhoff suggested the travelling trophy have the name of a famous Hawaii botanist.

Beatrice Krauss was speaker of the month. Her topic was Hawaiian medicinal plants.

Respectfully submitted,
Julia Williams, Secretary

Minutes: October 5, 1981 Meeting

President Baker called the meeting to order. Neither treasury nor membership reports were given. Wayne Gagne of the Conservation Committee issued his report. Attorney Bob Miller has been contacted with regard to the plight of the endangered plants species at Pohakuloa Training Area. He has, in turn, contacted Col. Hight at Ft. Shafter in hope that a meeting will be set to discuss a compromise plan for protecting the plants' habitat. Wayne then read a motion expressing the need for habitat protection for the three endangered plants--Stenogyne angustifolia var. angustifolia, Haplostachys haplostachyus var. angustifolia and Lipochaeta venosa. The membership supported the motion unanimously.

The Native Plants report was given by Evangeline Funk. On a recent trip to Lana'i she found that the Abutilon menziesii previously reported from the island could no longer be found. Paul Kores reported that the orchid Habernaria holochila has recently been seen on Maui for the second and third times.

President Baker called for new nominating committee members for the 1982 Botanical Society officers. He also announced that Bill Bush has consented to audit the Botanical Society's books for 1981.

As of October no name has been selected for the Botanical Society's Science Fair travelling trophy.

November was chosen as plant donation month.

Plant of the month speaker was Art Whistler. He presented a slide show on the rare Atepahia of Tahiti.

Pat Kirch of the Bishop Museum was Speaker of the Month. His talk concerned the effects of Polynesians as settlers on the island of Hawaii.

Respectfully submitted,
Julia Williams, Secretary

Minutes: November 3, 1981 Meeting

The meeting was called to order by President Baker who also gave the Treasurer's report. There was \$1745.57 in the Society's checking account at the end of October.

No membership report was presented.

Dan Palmer of the Conservation Committee reported that State Forester Liebert Landgraf has agreed to follow State guidelines in all future forest clearing projects, although no written agreement has been filed as yet.

The nominating committee for the 1982 slate of officers is Keith Woolliams, Sy Sohmer, and Art Whistler. They have selected the following slate:

President -	Paul Kores
Vice-President -	Joan Canfield
Secretary -	Kristen Schlech
Treasurer -	Derral Herbst
Directors -	Ray Baker, Betsy Gagne

Plant of the month speaker was Joan Canfield. Her topic was plants of the Alakai Swamp.

Mia Touw was speaker of the month. She spoke on the "Ethnopharmacological Studies Among the Tibetans of Dharamsala."

Respectfully submitted,
Julia Williams, Secretary

ANNUAL REPORT OF THE SECRETARY FOR 1981

1981 marked the 57th year of the Hawaiian Botanical Society. The officers for 1981 were:

President -	Ray Baker
Vice-President -	Paul Kores
Secretary -	Julia Williams
Treasurer -	Derral Herbst

This year was notable for the increased involvement of the Society in conservation matters. The Conservation Committee headed by Wayne Gagne, wrote letters and voiced concern over such matters as the illegal clearing of State land by State Forestry workers. This land included the native forest at Lapa Ridge on Kauai. State Forester Liebert Landgraf and several local conservation groups, including the Botanical Society, came to a tentative agreement as to the future procedure regarding forest removal in the State. Negotiations continued throughout the year.

Early on in this matter members felt the need to allot money to aid in legal action against such environmental degradation as occurred on Kauai. A proposal by Dan Palmer to put aside \$2000 from the Marie Neal Fund for this purpose was approved by the membership. A Conservation Committee operating budget of \$180 per year was also approved by the members.

During the year the Society contributed \$100 to the Conservation Council for Hawaii's Wildlife Week Program, as well as \$100 to the Waimea Arboretum for their rare plant introduction program.

The 1981 Science Fair winners were Sharon Yokayama (grade 10) and Mari Hamasaki (grade 12). Each was presented with a copy of Rock's Indigenous Trees of the Hawaiian Islands. Milton Manhoff suggested that a travelling trophy be part of the prizes for the winner's school. It would remain in the winner's school for a year and would then be moved to the school of each succeeding winner. This proposal was approved by the Society. However, as yet no name has been selected for the trophy.

Kirk Apt was named Outstanding UH Botany student for 1980 by the Society.

One Botanical Society Newsletter, Volume 18, was produced during 1981.

February, May and November were plant donation months.

Speakers of the Month for 1981 were:

January - Dr. Bates (Cornell): "Hunter-Gatherers, The Origin of Agriculture"

February - Al Samuelson (Bishop Museum): "Travels Through the New Hebrides"

March - Sy Sohmer (Bishop Museum): "The Flora of Ceylon Project"

- April - Hardy Spoehr (Nature Conservancy): "The Nature Conservancy in Hawaii"
- May - Sheila Conant (UH General Science): "Fauna and Flora of Nihoa Island"
- June - Beatrice Krauss (Lyon Arboretum): "Hawaiian Medicinal Plants"
- October - Patrick Kirch (Bishop Museum): "The Effects of Polynesian Settlements on the Island of Hawaii"
- November - Mia Touw (Bishop Museum): "Ethnopharmacological Studies Among the Tibetans of Dharamsala"
- December - Presidential address by Mr. Ray Baker (Lyon Arboretum): "The history of the Lyon Arboretum."

Respectfully submitted,
Julia Williams, Secretary.

Minutes: December 7, 1981 Meeting

President Baker called the meeting to order. Derral Herbst presented the annual Treasurer's report.

Wayne Gagne presented the Conservation Committee report. There has been a meeting between conservation groups and the military regarding endangered plants at the Pohakuloa Training Area. The Blair Logging Company is trying to obtain permission to log on Parker Ranch. They have proposed construction of three roads to reach the land. These would pass through native koa forest. The Department of Land and Natural Resources has issued a negative declaration.

The elections for the 1982 slate of officers was approved unanimously.

A name has been selected for the Botanical Society's State Science Fair Travelling Trophy: "The Hawaiian Botanical Society Science Fair Award." \$100 has been allotted for a koa plaque to serve as the trophy.

The controversy regarding the \$100 due the Wau Ecology Institute has been resolved. The Society unanimously approved sending the check to Lyn Gressitt at the Institute.

Ted Green has suggested that the names of all Botanical Society officers be listed in each edition of the Society's Newsletter.

There was no Plant of the Month Speaker.

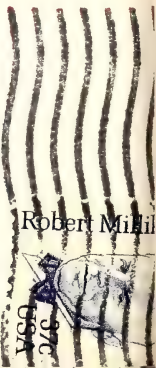
Speaker of the month was President Baker. His address was on "The History of the Lyon Arboretum."

Respectfully submitted,
Julia Williams, Secretary

NEWSLETTER
HAWAIIAN BOTANICAL SOCIETY
c/o BOTANY DEPARTMENT
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Hawaiian Botanical Society



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CANOPY DIEBACK IN INDIGENOUS FORESTS OF PACIFIC ISLANDS:
HAWAII, PAPUA NEW GUINEA AND NEW ZEALAND

Dieter Mueller-Dombois
Department of Botany
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In our indigenous rain forests, particularly on the Island of Hawaii, we have noticed many places with dead standing trees. In 1968 I referred to this dieback phenomenon in a paper (Mueller-Dombois and Krajina 1968) describing the vegetation patterns on the eastern slopes of Mauna Kea. Since that time considerable research has been done to find the cause or causal mechanisms that may be considered responsible for the dying or dead tree stands in the Hawaiian rain forests.

During the last seven months of my sabbatical year I had an opportunity to travel with my wife through the Melanesian Islands including New Zealand. This journey was the outcome of a long-planned research expedition to collect the material for a book on the vegetation of the Pacific Islands. In particular I was interested in visiting many of the other "Big Islands" of the Pacific, i.e. those that still have or should have considerable areas of indigenous lowland and montane forests left. In addition my concern was with current logging and forestry operations and the agricultural situations of the Melanesian Islands and the people.

In visiting indigenous island forests, I was especially interested in the canopy species and their reproductive status. I thought that perhaps similar patterns of dead standing trees—as are typical for Hawaiian forests—may also be found elsewhere. This special focus paid off. Not exactly the same, but similar patterns of dead or dying tree stands are common in certain other Pacific island forests.

Before explaining these patterns, I would like to briefly review the dieback phenomena, the research history and current findings with regard to the Hawaiian rain forest dieback or decline as it is often called here. Thereafter, I will talk about dieback in other islands and then will draw some conclusions as to the dieback causes and associated implications.

Dieback in the Hawaiian Rain Forest: a brief summary

After the dead standing tree patterns in the Metrosideros rain forests became a concern of the Hawaii State and the U.S. Forest Service, it was a publication by Petteys, Burgan and Nelson in 1975 that drew attention to a rapid decline of this forest on the Big Island. A prediction was made that if the epidemic decline would continue as it had been since 1954, the presently remaining 'ohi'a rain forest on the east side of Mauna Kea and Mauna Loa would be dead in another 15 to 25 years.

It was suggested that a new disease had entered our rain forests and now was killing trees of all sizes. Research was focussed for many years on finding the causal agent. After screening for a number of potential disease-causing fungi, the root pathogen Phytophthora cinnamomi was

suspected to be the killer. Then, when the correlation of dead and dying tree patterns with this root fungus became less clear, the endemic 'ohi'a borer (*Plagithmysus bilineatus*) was temporarily suspected to be the killer. Both these biotic agents have not been discarded as being involved in the 'ohi'a decline, but their role as triggers or primary causes have been effectively eliminated with the research publication of Papp, Kliejunas, Smith and Scharpf, which appeared in Forest Science in 1979.

As an alternative to the disease (or biotic agent) hypothesis I presented in 1974 a research hypothesis that focussed on the decline or dieback as a natural phenomenon in primary succession (Mueller-Dombois 1974). When funding was obtained, a second research group, consisting primarily of graduate students from our Department of Botany, began to attack the puzzle with fundamental ecological research. At this time, I will not discuss this kind of research that added several other important findings to the dieback phenomenon (Mueller-Dombois 1980). I will only mention here the names of four graduate students whose contributions helped substantially to unravel the dieback problem as we understand it today. They are Jim Jacobi, Ranjit Cooray, Nadarajah Balakrishnan and Grant Gerrish.

The most significant findings to date about the 'ohi'a rain forest dieback can be summarized into seven points:

1. Poor correlation of dead or dying tree stands with disease causing fungi (Hwang 1977, Papp et al. 1979).
2. Better correlation with the endemic 'ohi'a borer; but this insect was proven not to be the killer (Papp et al. 1979).
3. Recovery of dying trees by application of NPK fertilizer (Kliejunas and Ko 1974) suggesting that nutrient deficiency was involved.
4. Dieback more or less restricted to the canopy *Metrosideros polymorpha* trees, i.e. trees which had their foliar biomass in the upper vegetation stratum (Mueller-Dombois et al. 1977).
5. Dieback—in many cases—associated with reproduction of the dying species (*Metrosideros polymorpha*) (Mueller-Dombois et al. 1977).
6. Dieback patterns found to differ markedly with site, i.e. different patterns occur on lava flows and ash soils and these again differ with drainage and soil nutrient levels (Mueller-Dombois et al. 1977). So far we have recognized five different patterns.
7. Individual dieback stands die at different times in a random mosaic, i.e. a canopy tree group may die in one area, while a similar one remains stable in another. Moreover, there are older patterns of dieback which are presently characterized by advanced pole-sized stands growth of 'ohi'a (Mueller-Dombois 1981).

With this information I will now leave Hawaii and discuss forest dieback in other islands.

Dieback in indigenous forests of other islands

Again, I may summarize:

1. In lowland tropical rain forests, canopy dieback seems to be very rare. In spite of thorough observation in Fiji, New Caledonia, Papua New Guinea, the Solomon Islands and Vanuatu (formerly the New Hebrides), I found tree group death only in a few places. On the island of New Britain (in the Keravat District) occur stands of lowland rain forest dominated by the indigenous Eucalyptus deglupta. Some of these exhibited canopy dieback. A mature Acacia species population growing on two adjacent volcanic slopes at Rabaul also had died, leaving the slopes dotted with many dead standing trees. There was a dead lowland rain forest stand in New Caledonia, but this stand had died as a result of flooding from hydroelectric development, and I should emphasize that I include only those observations where the cause of tree death is not obvious. For example, tree stands killed by fire or by ring-poisoning and other man-induced disturbances are not included.
2. In montane tropical rain forests, I observed canopy dieback in several places, particularly in Papua New Guinea, Sri Lanka, and New Caledonia. In all three cases, dieback was found among the members of a single dominant canopy species.
3. In certain subtropical and temperate forests of New Zealand, patchy canopy dieback is a very common phenomenon. Forests with tree-group dieback are again only those with single or a few dominant canopy species. They include both Nothofagus (southern-hemisphere beech) and Metrosideros (rata) forests.

Since I have already discussed the New Guinean dieback in a separate paper (Mueller-Dombois 1982), I will restrict my remarks here mainly to the New Zealand diebacks.

Among Nothofagus it is particularly mountain beech (N. solandri var. cliffortioides) which shows tree-group or canopy dieback. On the South Island in Craigieburn Forest Park (near Christchurch), mountain beech forms an almost monospecific forest system. Here certain mountain slopes are dotted with small dead tree groups. Upon closer examination one finds that dense seedling groups of mountain beech are growing beneath the dead tree groups. These seedling groups are obviously cohorts, i.e. seedlings of the same seed crop or regeneration wave. One can even find seedling groups of different sizes, i.e. small seedling stands together with recently dead parental tree groups, taller seedling stands with parental tree groups that obviously died a while ago, or advanced pole-sized stands with few dead standing and several parental trees on the ground.

On the North Island in Tongariro National Park, mountain beech forms a mixed forest with two other Nothofagus species as co-dominants, i.e. with silver beech (N. menziesii) and red beech (N. fusca). Mountain beech currently exhibits tree-group dieback. Here, the reproduction seems to consist mostly of seedlings from silver and red beech, while mountain beech seedlings are lacking. In this case, mountain beech dieback appears to represent a successional decline of this species which seems to become replaced by the two other beech species.

There are three stand-forming Metrosideros species in New Zealand. Other Metrosideros species are vines of lesser ecological importance. The three stand-forming species are southern rata (M. umbellata), northern rata (M. robusta) and pohutekawa (M. excelsa). Southern rata is a forest dominant together with Weinmannia racemosa on the western side of the South Island in the "beech gap," an area (south of Kumara and north of the southern Fjords) so-called because of its absence of Nothofagus. Northern rata occurs in the area around Wellington, i.e. in the southern part of the North Island and in the northern part of the South Island. Pohutekawa is widely grown as an ornamental on the North and South Islands. Under natural conditions it forms, for example, the single canopy dominant on Rangitoto, a small recent volcanic island in Auckland Bay.

All three Metrosideros species exhibit canopy dieback. The worst is seen in southern rata stands, for example, in Westland National Park, where dieback is particularly common at Franz Josef Glacier above the 1750 "trimline," that is above the position of the glacier before it retreated in 1750 further back to the valley head. Below the 1750 "trimline" southern rata stands are mostly vigorous and do not exhibit much dieback.

The dieback of northern rata (M. robusta) near Wellington has been carefully studied over the past few years at the Orangerango Field Research Center of the Department of Scientific and Industrial Research (DSIR). It was concluded that the opossum (Trichosurus vulpecula), introduced to New Zealand from Australia in the latter half of the 19th Century, is the killer of Metrosideros. The opossum has multiplied to epidemic proportions and apparently feeds severely on Metrosideros foliage. Dr. R. E. Brockie, head of the Ecology Unit of DSIR at Orangerango, pointed out that southern rata is affected more on harsh and wind-exposed sites and at its upper elevational distribution range as contrasted with wind-sheltered and more favorable habitats and in its distribution center. Opossum is also generally believed to be the killer of southern rata. Yet, when I spoke about the Hawaiian Metrosideros dieback, which here occurs without opossum, I was told that there is a controversy in New Zealand about what kills Metrosideros there. I was given a report in which the writer noted that rata dieback was seen to occur even before introduction of the opossum. Moreover, this person strongly believes that the killer is a scale insect. However, the scale insect when identified by the specialist of scale insects (J. M. Hoy) turned out to be the endemic host-specific Anoploplitis metrosideri. In this specialist's opinion, the scale insect could not be the killer. The population buildup could be explained as a consequence of the trees dying, i.e. as an effect rather than a cause.

Conclusions

Since it is widely believed that island ecosystems are fragile, the first guesses that were made about the dieback phenomenon in Hawaii and elsewhere were that dieback is the result of new stresses or disturbances caused by the activity of humans. In Hawaii, it was believed to be a new disease or insect pest or a combination of the two, perhaps involving feral pigs as a vector. Air pollution had also been suggested. Other factors considered included climatic change. Similar reasons were suggested in Papua New Guinea (Mueller-Dombois 1982) and New Zealand.

As research began in each of these areas, the story became more complicated. A single factor seemed less likely to be the killer and a combination of factors was suggested. In Hawaii, dieback was thought to be related to a combination of changing weather patterns, soil water and nutrient regimes, forest stand condition, disease causing agents and insect damage. The "combination-of-factors-idea" is also well expressed in the following statement by Julian Ash (1981: 374) who researched the Nothofagus dieback in Papua New Guinea on Mount Giluwe: "Dieback is usually associated with a combination of weather, substrate, pathogens and hosts at a suitable stage of development."

Continued work in Hawaii allowed us to further unravel the causes into primary and secondary causes or into trigger and subsequent factors. We are now very certain that biotic agents are not the dieback triggers in Hawaii. The same is true for the Nothofagus dieback on Mount Giluwe. Dr. Frans Arenz (personal communication) will soon publish data to this effect.

Because of this new "causal-chain-reaction-idea" I was able in our 1981 progress report (Mueller-Dombois 1981) to boil down the possible causes to three alternatives:

1. Dieback is caused by an environmental perturbation which is site specific, e.g. root-flooding after several abnormally wet years in depressional habitats, or root-drying in well drained habitats during an unusually dry year.
2. Dieback is a function of cohort senescing, i.e. simultaneous loss of vigor due to an interaction of age and site factors (e.g. low nutrient supply).
3. Dieback is a function of cohort senescing followed by a site-specific perturbation.

After having seen that canopy dieback is a common phenomenon in certain kinds of forests, in particular in certain Eucalyptus, Metrosideros and Nothofagus forests, I am ready to discard the first alternative and restate my new hypothesis as one, namely: "Dieback is a primary function of cohort senescing which can be further synchronized by certain secondary and tertiary environmental perturbations."

This hypothesis is in harmony with the seven important findings that resulted from the Hawaiian dieback studies and it is also in harmony with the facts brought out in the other indigenous forest diebacks mentioned. Therefore, it can now be called a scientific theory.

What this theory says in fact is that dieback is a natural and recurring phenomenon in forests that are dominated by canopy species which are relatively shade-intolerant pioneer or early seral species and which reproduce by wave regeneration. The pattern of dieback is largely a function of the spatial distribution of the cohort that became successfully established from a wave regeneration in the past.

This new theory has important implications to our understanding of succession and climax and it has application with regard to three practical questions:

1. The size of natural areas.
2. The size of cropping systems (where a commercial tree species is involved, e.g. in Nothofagus pullei in Papua New Guinea).
3. The vigor of indigenous versus introduced forests.

I would like to emphasize, however, that the reduction of the possible dieback causes to one primary causal mechanism as presented here should not put us into an equally wrong thinking mode, i.e. to believe that all dieback is natural and therefore our ecosystems are not threatened. The chance of a foreign disease entering our islands and thus destroying large parts of our native biota is still a possibility that we should guard against as much as possible.

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SOCIETY BUSINESS

PUU LUA-KOKEE HYDROPOWER PROJECT, KAUAI.

The project proposes to construct an earthen dam on Kawaikoi Stream and create a reservoir by backing the water up into part of the Alakai Swamp. The dam will be sized to provide enough storage so that a constant and increased flow can be provided to the proposed hydropower plants and irrigation systems of Kekaha Sugar Company as well as for the maintenance of a fish population and sediment load. The proposed project would utilize the existing Kokee Ditch system to Puu Lua Reservoir. By constructing a penstock from the Puu Opaie-Kitano bifurcation on Kokee Ditch to Puu Opaie and another penstock from the Kokee Ditch to Mana Ridge, hydroelectric power can be generated and existing and new fields can be irrigated. The dam on Kawaikoi Stream will have an active storage of 5 to 6 billion gallons with a surface area of the full reservoir of approx. 260 acres. The reservoir site is within the caldera of the Kauai volcanic cone and will be underlain by silty clay and bedrock. A water-tight reservoir is anticipated due to the favorable geologic conditions of deeply weathered and dense bedrock characteristics, the water table of the valley walls and the existence of perennial ponds in the existing stream channel. The dam will have a maximum height of approx. 190 ft. above the streambed and a crest length of about 1,000 ft. The spillway will be a concrete chute with an uncontrolled crest and a capacity capable of passing the maximum probable flood. A concrete conduit located at the bottom of the active storage pool will serve as the controlled outlet for the dam. The buried penstock to the Puu Opaie Power Plant will consist of approx. 16,000 ft. of steel pipe. An additional 15,500 ft. of steel penstock pipe will be required for the Mana penstock. The intake structures will each be provided with a sediment trap, fish screens wasteway and gate. The dual power plant system will utilize impulse turbines driving one 700-KW generator at the Puu Opaie Power Plant and one 2,000-KW generator at the Mana Ridge Power Plant. All the necessary electrical and mechanical equipment required for operation and maintenance will be provided with the power plants.

The Hawaiian Botanical Society directed the Vice-President, Joan Canfield, to write about its concerns to the Chairman of the Board of Land and Natural Resources. A copy of the letter follows.

November 10, 1982

Mr. Susumu Ono, Chairman
Board of Land & Natural Resources
Department of Land & Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

The Hawaiian Botanical Society has reviewed the EIS Preparation Notice on the Puu Lua-Kokee Hydropower Project, which you sent us October 27. As an officer of the Society, I was asked to repond, representing the Society as a whole in these remarks. We have a number of concerns about the project's overall desirability for the State and its environmental impact which we feel are not adequately addressed in the Preparation Notice.

1. Cost/Benefit Analysis

The EIS Preparation Notice includes no figures on the costs involved in this project, or the benefits the County and State will derive from it. In the absense of such data, it is difficult to evaluate the project's merits. But considering the uncertain future of sugar as a growth industry in Hawaii, we question the State's heavy investment in a project whose main beneficiary will be a single sugar company. It would be helpful for the Notice to include the Department of Planning & Economic Development's assessment of this project's long-term value to the State. The Notice mentions reducing unemployment and providing more jobs in agriculture on Kauai. Perhaps the Notice could designate the number of permanent new jobs that this project would create.

2. Irrigation Water Supply

Irrigation requirements of cane on a per acre basis in the proposed canefields would be a useful addition to the Notice. The amount of evaporative losses expected from the reservoir and the minimum 10-mile ditch system between reservoir and power plants should be considered.

We are concerned about the expected volume of the reservoir. For example, is the maintenance of 5-6 billion gallons supported by average monthly streamflow data for Kawaikoi Stream above the dam site during summer?

The reservoir's expected lifespan is not indicated. We are concerned with the effect of the heavy rainfall in Alakai Swamp and the steepness of the reservoir's slopes on siltation. What is the estimated rate of silt deposition in the reservoir? Its effect on the reservoir's capacity on an annual basis over the next several decades should be considered. Perhaps periodic dredging of the reservoir should be included in the project description.

We are concerned with the strength of an earthen dam of local fill. Supporting data from hydrologists or geologists would be reassuring. The risks and consequences of dam failure deserve more attention in the Notice. One-half mile downstream of the proposed dam site is Sugi Grove Camp. This

popular campground will receive more visitors once the project's access roads are improved. Camp 10 Road beyond the crossing at Sugi Grove will also receive more traffic. The human risks associated with dam failure need to be re-evaluated in this context.

3. Hydroelectric Power Generation

From the Notice, it is difficult to determine the amount of power that will be generated by this project. A figure is given for the 1964 Kokee Water Project, a different proposal from the present one. The only pertinent data concern the size of the two generators. However, their combined 2.7 megawatt capacity gives a maximum capability, rather than the expected level of power generation. What is the projected average level of hydroelectric power generation?

The distribution of this hydropower is not specified in the Notice. What percentage of power will be absorbed by Kekaha Sugar Company, and how much will the County be sold? If this project is designed to make power available to local users, then the project description should mention the construction of powerlines to span the minimum 5-mile distance between any of the power plants and Waimea, Kekaha, or Kokee.

If hydropower production for Kauai is one of the project's major objectives, we wonder how this plan measures up against the five alternative potential hydropower sites recommended by the Department of Planning & Economic Development's 1981 survey. A discussion of the relative merits of these alternative sites should be given in the Notice.

4. Environmental Impacts

The Hawaiian Botanical Society questions the use of 125 acres of a declared State Wilderness Preserve and proposed Natural Area Reserve for use as part of a reservoir that will primarily benefit one private enterprise. The Notice points out the value of the reservoir and borrow area sites in terms of the rich native flora and fauna, and the surrounding area's susceptibility to disturbance from a project such as this one. We are curious about what the Division of Forestry & Wildlife and Division of Aquatic Resources have to say about the location and impact of this project.

4a. Earth-moving and Road-building Activities

The Notice does not indicate the location and extent of all access roads required for this project. Only brief mention is made of the new roads needed for access to the dam and borrow areas themselves. They are not shown on Figure 2. The amount of earth-moving and leveling necessary to build access roads on the steep slopes of Kawaikoi Stream is not discussed. The access road to the dam may destroy the Kawaikoi Stream Trail.

Topographically, the most suitable access to the westernmost borrow areas appears to be from the northern limit of the main borrow area, that is, from the Alakai Swamp Trail just below Lehua Maka Noe bog. This route would affect an additional 2000 ft. band of Forest Reserve land.

The consequences of converting Camp 10 Road to all-weather standards are not adequately addressed, we feel. Paving, widening, and construction of ditches should be noted if planned. If the road is widened, the extent of blasting and removal of cliff faces along the road concerns us. Erosion, siltation, and vegetation destruction from these activities are adverse environmental impacts which should be included in the Notice.

4b. Vegetation

The Notice makes no mention of endangered species. A candidate endangered species, Euryua sandwicensis var. grandifolia Wawra, grows in the borrow area. The area between Kokee and the Alakai Swamp is especially rich in restricted endemic plant species. The presence of such species, some of which may deserve endangered status, should be determined for all areas impacted by the project. This should include widened access roads, penstock trenching areas, and power plant sites, as well as the actual reservoir and borrow areas. The presence of significant native vegetation on the 600 acres of leeward ridges proposed for conversion to canefields should be more carefully considered.

Disturbance to Lehua Maka Noe bog, due to increased drainage, is noted in the Notice. The main borrow area, as mapped in Figure 2, lies directly downslope and within 90 ft. of Lehua Maka Noe bog. It is not made clear how this borrow area will be "designed to minimize the possibility of increasing the drainage from the bog area."

This bog is of considerable value: it is the only bog in the Alakai Swamp easily accessible to visitors. The Alakai bogs are a unique native habitat, representing the oldest and best developed bog vegetation in the State. Lehua Maka Noe is also culturally significant, as it is celebrated in many Hawaiian songs.

The Notice proposes to revegetate cleared areas, minimizing the influx of exotic species. We are concerned with the success of revegetating borrow areas after they have been scraped down to bedrock level.

The first half mile of the Alakai Swamp Trail provides an appropriate example of the revegetation potential of the main borrow area. On the first 1/8 mi., the dense, gray clay is exposed along the trail cut. The ground surrounding the trail is virtually bare. The next 3/8 mi. of the trail consists of gravelly material overlying bedrock clay. Again, the plant cover is very scanty, even beyond the traveled portion of the trail, and consists of exotic grasses. These sites are both located within the proposed borrow area.

A similar scraped area is found on the next ridge to the northeast, at the head of Kalalau Valley east of Puu O Kila. Decades after that route was bulldozed, it remains largely bare and is still eroding. We are concerned that a similar situation be avoided in the 50-100 acre borrow areas proposed along the Alakai Swamp Trail.

The Notice rightly recognizes the influx of exotic plants as a problem. Blackberry and banana poka are aggressive weeds already established along Camp 10 Road and lower Kawaikoi Stream Trail. At present, however, they are largely restricted to roadsides and clearings.

Since they become established in newly cleared areas, the hydropower project will promote their spread greatly. The State has invested considerable effort in its exotic weed control program, particularly in the control of blackberry. Given the State's commitment to controlling recognized exotic pests, planned control measures belong in the Notice.

Increased visitor traffic will introduce more exotics to the Alakai Swamp, as stated in the Notice. It would be helpful if the Notice explained how disturbed areas will be maintained "to prevent exotic plants from becoming further entrenched in the project area." Perhaps this maintenance phase should be considered in the cost/ benefit analysis of the project.

4c. Other Organisms

We are concerned about the consequences of siltation during project construction on the streamlife of Kawaikoi Stream. The Notice does not indicate how long the construction phase is expected to last.

The endangered koloa is common on Kauaikinana Stream where it intersects Camp 10 Road. The native duck nests on Kawaikoi Stream between Sugi Grove and the proposed dam site. The impact of construction on the koloa population deserves attention in the Notice.

The Hawaiian Botanical Society appreciates the opportunity to respond to the EIS Preparation Notice. We look forward to your response and to the incorporation of our concerns in the production of the EIS.

Sincerely,

Joan E. Canfield, Vice President
for the Hawaiian Botanical Society

NOTE FROM THE EDITOR

There was a most unfortunate error on the front page of the last volume of the Newsletter. The volume number was incorrectly printed as 21. It should have read 20. The header of the pages in the Newsletter were correctly printed. Most copies of the issue were corrected by hand before they were sent out to members of the Society. However, it is recommended that you check your copy to ensure that the number has been changed.

I apologize for the error.

Minutes of the January 4 Meeting

President Kores called the meeting to order. Bob Busch complimented Derral Herbst on his fine job as Treasurer and Derral gave the Treasurer's report as follows:

Balance as of December 1.....	\$1,787.57
Receipts.....	254.00
Expenditures.....	270.00
Balance as of December 31.....	\$1,771.57

There were no reports from the Conservation and Native Plants Committees.

Under new business, Dr. Charles Lamoureux announced a public hearing on Thursday, January 7 in Hilo concerning Blair Ltd.'s proposed access roads in Lapahoehoe. A motion was made that the Hawaiian Botanical Society recommend there be no amendment to the Conservation District Use Application for this proposal to put three logging roads through the Lapahoehoe State Forest and Natural Area until the EIS procedure is completed. The motion was seconded, voted and passed unanimously.

The Plant-of-the-Month Speaker was John Obata, who talked about native gardenias. The Speaker of the Month was Dr. Isabella Abbott and her topic was "Plant Resources for Making Tapa".

Respectfully submitted,
K.E. Schlech

Minutes of the February 1 Meeting

President Kores called the meeting to order at 7:30. The January minutes were read, amended and approved. Paul Kores gave the Treasurer's report for Derral Herbst as follows:

Balance as of January 1.....	\$1,771.57
Receipts.....	17.50
Expenditures.....	26.00
Balance as of January 31.....	\$1,763.07

Native Plants Committee Report: Wayne Gagne announced that Volume 1 of the Rare and Endangered Plants book, authored by Dr. Harold St. John and Dr. Carolyn Corn, is now available.

Conservation Committee Report: Paul Kores discussed the interaction of the Society with the legal services of Bob Miller, of the Wayne Pitlock Law Firm. On January 29, several representatives from a variety of organizations met with Bob Miller to discuss the recommendations on several issues regarding the Pohakaloa Training Area situation. The military appeared receptive and are constructing firebreaks around the kipukas in the Training Area. There was disagreement on some items, particularly the removing of fire points from the kipuka Kalawamauna, which harbors the three endangered plants, as well as being within the critical habitat for

the palila, a honey creeper endemic to the Island of Hawaii. The overall attitude was hopeful for future compromise.

New Business: At the last meeting, a motion was made to recommend that no amendment be made to Blair Ltd.'s Conservation District Use Application for logging roads in Lapahoehoe until an Environmental Impact Statement had been completed. At the public hearing in Hilo, it was stated that an Environmental Assessment should be done and an EIS should be filed. The Environmental Quality Commission, which would review the EIS, agreed and recommended to Mr. Sus Ono, the head of the Dep't. of Land and Natural Resources, that this procedure be followed. Mr. Ono indicated there was no need for these documents and filed a negative declaration. Bob Miller, representing the Hawaiian Botanical Society and the Audubon Society, contacted the lawyer of DLNR, and submitted a declaration asking for an EIS. A preliminary restraining order was filed by the Audubon and Hawaiian Botanical Societies on Friday, January 29, 1982. Dieter Mueller-Dombois asked about the size of Blair's operation and previous Blair activities were discussed. It was suggested that the integrity of the Blair operations in general might be open to question as far as conservation was concerned. One problem is that the area involved is State-owned land slated for preservation, but the plan has not yet been approved by the appropriate parties.

Under new business, a refreshment committee was requested and a sign-up sheet was passed around.

Plant-of-the-Month Speaker was Debbie Ward, speaking on "Plants of Java". Speaker of the Month was Dr. Dieter Mueller-Dombois, whose subject was "Canopy Dieback in Indigenous Forests of Pacific Islands; Hawaii, Papua New Guinea, and New Zealand".

Respectfully submitted,
K.E. Schlech

Minutes for March 1 Meeting

Vice President Joan Canfield called the meeting to order at 7:30. We had several guests, including Dave Neal, who is from the Missouri Botanical Garden and in Hawaii for a short time working on Erythrina. The February minutes were read, amended and approved. The Treasurer's report was given by Derral Herbst as follows:

Balance as of February 1.....	\$1,763.07
Receipts.....	30.00
Expenditures.....	127.56
Balance as of February 28.....	\$1,665.51

There was no native plants report this month, but Wayne Gagne gave a detailed conservation report. On the Pohakaloa situation, the training ground utilized by the military - apparently, the "big brass" of the Army was not aware of the fact that firing was still going on and it now appears that the training periods will be altered and the fire breaks will still go through. The Environmental Impact Statement for the Training Area may be

affected by changes in the Reagan administration or the previous executive order for EIS statements at military installations could be rescinded. Byron Baker has asked the House Resolution Committee to call the Army on their maneuvers and the consequential effect on the papila.

The update on the Lapahoehoe issue, which involves the effects of logging roads through land designated for conservation, is that the lawyer representing the Society, Bob Miller, has now received depositions from three other parties: Dean Ichida, who initially stated that an EIS was not necessary; Caroline Corn, the State Botanist; and Rick Scudder, of SETS (formerly of EQC). It was again pointed out that there was a pre-existing wagon trail through the Waipuna area which could be used instead of constructing new access roads. Wayne then made a motion that we allocate \$84.61 from the general fund to pay the balance of the lawyer's fees. The motion was seconded; there was no discussion; and the vote was passed unanimously.

Under new business, Vice President Canfield announced that Betsy Gagne was the new Membership Chairwoman and Betsy kindly pointed out that all but seven people present at the meeting were guests.....dues are due.

Debbie Ward offered her services as judge for the Hawaiian Botanical Society at the 1982 Science Fair. This year, for the first time, the Society will be presenting, in addition to the books usually awarded, a plaque to be hung in the high school of the winner.

It was also announced that attempts were being made to put together an editorial committee to get the newsletter rolling again, and volunteers were requested.

Another announcement concerned the plant sale scheduled for the April meeting. Ted Green suggested the idea expanding the plant sale to include jams, jellies and a generally looser definition of 'plant'.

Our Plant-of-the-Month and Speaker of the Month speakers were Wayne and Betsy Gagne, who gave a lecture and slide show on "Conservation Problems and Prospects in New Zealand".

Respectfully submitted,
K.E. Schlech

Minutes of the April 5 meeting

The meeting was called to order by President Kores at 7:30. The March minutes were read, amended, and approved. Guests for April included Lucian Kramer, the endangered species zoologist for the Fish and Wildlife Service; Pam Green; Malcolm Grear; and Linda Hamilton. Derral Herbst gave the Treasurer's report as follows:

Balance as of March 1.....	\$1,665.51
Receipts.....	2,044.50
Expenditures.....	2,070.52
Balance as of March 31.....	\$1,631.49

Under old business, thanks were given to Debbie Ward for all her help in the judging of the Science Fair Projects and to Joan Canfield, our Vice President, for assembling a very attractive display for the Society at the University of Hawaii 75th Anniversary Open House.

There was no Conservation Committee report this month as Wayne Gagne was on the mainland, neither was there a Native Plants Committee report. We are sad to announce that Dan Palmer will be stepping down from his post as Chairman of the Native Plants Committee due to other commitments. The Hawaiian Botanical Society thanks him for all his help. Dr. Palmer has graciously offered to continue to serve on the committee under a new Chairman.

New Business included the announcement of the winners of the Science Fair: Anne Clements of Wheeler High School received a copy of Marie Neal's "In Gardens of Hawaii", donated by the Bishop Museum Publications Dept., and the Hawaiian Botanical Society plaque to be hung in her school for her project, "Kukui Nut Dyes". Jonathon Lindsay of Iao Intermediate School received a copy of "Hawaii: A Natural History", donated by the Pacific Tropical Botanical Garden, for his project, "Endangered Hawaiian Plants".

Also under new business, it was announced that stamps were available in the Governor's office as of April 4, 1982. The Membership Committee report was given by Chairman Betsy Gagne. Many members still owe dues. Announcements yielded the unfortunate news that the bill on the introduction of the freshwater eel to Hawaii's water systems came up before the legislature again, for the fourth time, and it looks as though it may be passed. As of April 1, it had already passed the House and was going to the Senate. A call was made for constituents to make their feelings known to the Senate before this bill slips through.

Also announced was the offering of a summer course by the Waikiki Aquarium in conjunction with the Sea Grant Program. The course will begin at the end of July and will be centered at the Aquarium. This summer's course will take a look at Hawaii's coastal flora and will include field trips to Poamoho, Makapuu, Natatorium Reef Flats, and Kawainui Marsh. Ray Tabata (Sea Grant Program), Ken Nagata (Lyon Arboretum), and Marge Elliot (Army Corps) will lecture on the land flora and Kristen Schlech (Bishop Museum) will deal with the marine flora.

Our Plant-of-the-Month Speaker was Faith Roeleffs, who spoke to us about her recent work, which has focussed on the establishment of the Makiki Environmental Center, a non-profit private organization which sponsors educational programs and field trips geared toward environmental awareness and conservation. The Center and its programs are open to the general public. Although the organization gets no direct funding from the State, the Department of Land and Natural Resources has aided in providing tools, water, etc. Our Speaker of the Month was Larry Hamilton, a research associate with the Environmental Policy Institute of the East-West Center, who presented a slide show and discussion on "Mangrove Ecosystems Around the World". This slide show is part of an international effort to increase awareness of this very important habitat which provides the interface between land and sea in many areas.

Respectfully submitted,

Minutes of the May 3 meeting

Vice President Joan Canfield called the meeting to order at 7:30 and announced that President Kores had begun a five month trip to herbaria which will include presenting a seminar in Edinburgh, Scotland on his recent work with rhododendrons. The April minutes were read, amended, and approved. Joan gave the Treasurer's report for Derral Herbst, who was in the Mariannas, as follows:

Balance as of April 1.....	\$1,639.49
Receipts.....	77.00
Expenditures.....	18.77
Balance as of April 30.....	\$1,697.72

The Membership Committee report, from Betsy Gagne, suggested that a few checks had come in, but delinquency still abounds. Wayne Gagne had returned from a long trip to Washington and he presented a Conservation Committee report. Regarding the Pohakaloa Training Area, Wayne indicated that all involved, except the Army, attended the meeting and that Bob Miller had an update from the Army. Wayne reported that he had received boxes of information on the Lapahoehoe situation during his absence, all of which he would review.

Concerning the Endangered Species Act, reauthorization has been approved for another year, and support still appears strong. Other good news was that the "Eel Bill" was again defeated and mention was made of the efforts of Betsy Gagne, Steve Montgomery, and Allen Ziegler during the fight against the bill. Appreciation was expressed for their actions.

Steve Montgomery spoke for the Hawaii League of Conservation Voters and indicated that they had met on several occasions and discussed the problem of political action on conservation issues. The consensus was that not enough people were making the effort to vote on conservation issues. If there were more support, the League could publish surveys and records of voting to demonstrate where people stand on these issues.

Wayne announced the sad news of the loss of two of our longtime Society members, Dr. and Mrs. J. Lindsay Gressitt, who were tragically lost in an air crash in China last month. Dr. Gressitt was an avid conservation member and had a great interest in many Hawaiian issues as well as Pacific Basin conservation. Mrs. Gressitt shared these interests and was active in preventing the importation of the freshwater eel.

There was no Native Plants Committee report for May. Sy Sohmer, Chairman of Botany at the Bernice P. Bishop Museum, announced that the 10th Annual Association of Systematics Collections Symposium would be held from May 22 through May 27 at the Museum. He briefly outlined the format, which included lectures on museum problems, systematics and the law, and computerization, as well as a number of social events revolving around the symposium.

Under old business, an SOS has been issued again by Cliff Smith, editor of our belated newsletter, for more articles. Thanks went to Faith Roeleffs for acquiring for the Society an envelope stamped with the Hawaii State Bird and Flower from the Governor's office and a letter of

recognition for our support. Debbie Ward had some new business and told us of her trip to Maui where she had gone to the Maui Zoo and Botanical Garden in Wailuku, which she said was most interesting. However, she noted that Rene Silva indicated the Garden was in financial need and could use money for signs, manpower support, and fumigation. Faith Roeleffs moved that the Society allocate \$150.00 to the project and Lani Stemmermann seconded the motion. It was passed unanimously. In reference to the methyl bromide needed for fumigation, it was suggested that we try to acquire it at no cost from the Chemical Society, although it was also noted that a permit was required for its use.

Plant-of-the-Month Speaker was Anne Clements, who gave us a presentation of her "Kukui Nut Dye" project and brought her poster in for display. In lieu of Speaker of the Month, two BBC films were shown. One was the Evolution of the Silverswords and the other was Islands Within Islands.

Respectfully submitted,
K.E. Schlech

Minutes of the June 7 meeting

Vice President Joan Canfield called the meeting to order at 7:30. The May minutes were read, amended, and approved. Joan gave the Treasurer's report as follows:

Balance as of May 1.....	\$1,697.72
Receipts.....	-0-
Expenditures.....	12.99
Balance as of May 31.....	\$1,684.73

We had no Membership or Conservation Committee reports as the Gagne's were out of town and no Native Plants Committee report, as we have not yet elected a new chairman.

Under new business, Lauren Gill gave us a report of the Clidemia situation, which included the unfortunate news of its presence on the Na Pali Trail on Kaua'i. Clidemia has threatened the populations of several native plants, Stenogyne and kaneloana being two of those in danger. It was found at the end of May in the area where the Na Pali Trail crosses Hanakoa Stream. The Project Hawaii Science Trip Program, which is part of the Sierra Club, wants to take action and is calling for volunteers to attack the Clidemia population manually in a concerted effort to begin around early July and continue through August. For more information, contact Janette Lee, the coordinator of the program. Another possibility for eradicating this weed is anticipated as a result of entomological research currently being conducted. Last year, \$144,000.00 was awarded for research concerning Clidemia and banana poka, both considered of major influence in the decline of native vegetation in Hawaii. The entomological research focuses on elimination through biological agents, possibly a parasitic wasp.

Under old business, mention was made that Campbell Estates was providing financial support for McCoy's research follow-up salvage work on archaeological sites of the raised coral plain.

Our Plant-of-the-Month Speaker was Dr. Phil Rundel (U.C. Irvine) who gave a talk on "Sexual Dimorphism in Coprosma". Phil has been in Hawaii for the summer working on this project and others while his wife, Marti Witter, a botany graduate student at U.H., works on her research project involving isozyme genetics in Dubautia populations.

Our Speaker of the Month was another botany graduate student, Alan Holt, who gave a presentation on the "Present Condition of Native Dry Forest of Leeward East Maui". Alan's talk provided an excellent combination of historical notes regarding this area and interpretations of early collectors and recent researchers on the success or failure of current dry forest populations on Maui.

Respectfully submitted,
K.E. Schlech

Minutes of the October 4 meeting

Treasurer Derral Herbst called the meeting to order at 7:30 pm, as President Kores and Vice President Canfield were both out of town. Guests included Tim Kranz and Ariel Wilson of Baldwin Lake, California and Peter Tausend of U.C. Berkeley, who is here working on the physiological ecology of Scaevola. The June minutes were read, amended, and approved. Derral gave the Treasurer's report as follows:

Balance as of June 1.....	\$1,684.73
Receipts.....	340.50
Expenditures.....	150.00
Balance as of September 30.....	\$1,875.23

The Membership Committee reported a recent count of 60 members. It was noted that membership in the Society in the past has surpassed the figure of 250, and it was suggested that we review the situation and propose suggestions for increasing both membership and participation in the Society.

There was no Native Plants Committee report as a new chairman has not yet been elected.

Wayne Gagne reported for the Conservation Committee on several pending issues: 1) The plans for the Laphoehoe logging access road proposed by Blair Co. have been cancelled in an out-of-court settlement. The agreement, in summary, is that if the proposed road (the third) is not constructed, there will be no legal opposition to the two existing roads, which are in violation of the Conservation District Use Application guidelines. 2) Pohakaloa Training Area negotiations are still continuing with a review of the fire management plan. 3) The Society has been asked to review the Kokee, Kaua'i hydroelectric project. 4) The Endangered Species Act passed overwhelmingly in Congress. 5) The Society received a

Rare and Endangered Plant Exchange proposal from Brooklyn College, New York. 6) The Society has been asked to review a proposal submitted by Marilyn Bornhorst which would attach an amendment to the City and County of Honolulu ordinances providing for the preservation of trees which are deemed "of a significant size". This would be an addition to Article 34, which covers "exceptional tree(s)" within the Waikiki Special Design District, and the Cultural, Historic, and Scenic Districts within Honolulu.

Under old business, Cliff Smith, editor of the newsletter, announced the near completion of the backlogged issues (1979-1982). He noted that he's received considerable help from Cheran Wilson, graduate student in Botany. Cliff is also working on a set of recommendations to be submitted to the Society, regarding future issues and direction of the Newsletter. One suggestion voiced was that the Newsletter be issued three times a year instead of five.

Under new business, Kristen Schlech proposed that the Botanical Society consider the possibilities of moving the center of activities to the Bishop Museum. Several positive aspects of this proposal, including free parking and potential increase in membership, participation, and attendance were discussed. As no objections were voiced, Schlech stated she would report back to the Society at the November meeting with an update including feedback from various Museum administrators concerning the feasibility and any drawbacks to the proposal.

Under announcements, Chris Simon reported on the special issue of Natural History which will be devoted to Hawai'i. Many articles in this 1982 issue will be written by University of Hawai'i and Bishop Museum staff and a half price offer is extended to members. Anyone interested in more information should contact Chris through Zoology at U.H. Manoa.

There was no Plant-of-the-Month Speaker. Our Speaker of the Month was Alan Holt, U.H. botany graduate student working for The Nature Conservancy, who spoke on "The Role of the Nature Conservancy in Protecting Native Vegetation Areas in Hawai'i", specifically the approaches taken in managing certain areas of Molokai Ranch.

Respectfully submitted,
K.E. Schlech

Minutes of the November 1 meeting

The meeting was called to order by Vice President Canfield at 7:30, as President Kores is still out of town. The October minutes were read and approved. Derral Herbst gave the Treasurer's report as follows:

Balance as of October 1.....	\$1,875.23
Receipts.....	57.00
Expenditures.....	-0-
Balance as of October 31.....	\$1,932.23

There were no reports from the Membership, Conservation, and Native Plants Committees.

Under old business, Kristen Schlech brought up the proposal that was sent to the Society from the City Council regarding an ordinance for the protection of trees of a significant size. Certain points of the proposal such as the definition of significant size, were discussed and a few suggestions regarding potential additions to the draft were brought up, most notably the incorporation of native plants in addition to trees of significant size. A motion was made to respond favorably and to include suggestions. The motion was seconded and passed unanimously.

Also under old business, Schlech presented a report on the proposed move to Bishop Museum, reporting that she had received very favorable response to the idea from Museum personnel, that the rental fee for the conference room required would be approximately \$25.00 per meeting, and that the facility would be available shortly after January, 1983. Schlech also noted that she had received favorable response from some Society members who felt the proposed move would accomodate many more members than the current University of Hawai'i facility does. The question of why the Society would want to move from the University facility was again brought up. The following reasons were put forward by Schlech: 1) The University is experiencing personnel cutbacks, as well as space limitations; 2) The University does not provide non-profit organizations with free meeting facilities; 3) Facilities once extended to the Society for a period of one year now must be requested at three-month intervals. Some members questioned the validity of these arguments and expressed concern about the source of funds for rental. It was suggested that the Society schedule a trial meeting at the Museum and then make a decision on the move.

Further old business clarified the status of Gladys Baker, an honorary member in the Society, and noted that she was not one of the trustees of the Marie Neal Fund.

Under new business, the Secretary presented to the Vice-President a slate of nominations for the December elections of executive council members and committee chairmen. The slate was assembled by an Ad Hoc Nominations Committee composed of Kristen Schlech, Wayne and Betsy Gagne, and Charles Lamoureux. It was stressed that the Society does not have any volunteers to chair the Native Plants Committee and as native plants are the priority of the Society, according to its constitution, it was urged that members probe their consciences about this position. It was announced that nominations would be received by mail or phone any time prior to the December elections.

Lani Stemmermann brought us up to date on activities regarding the proposed geothermal project on the Big Island; testimony was being taken in Hilo, but had been postponed due to elections. She informed the Society of several of the negative aspects of this proposed project and moved that the Society donate \$200.00 to offset some of the legal costs of fighting this project. The motion was seconded but did not pass. Some of the positive aspects of the geothermal project were also noted and discussion was continued on a pro and con basis. Clarification was made that the geothermal concept in itself was not necessarily the issue. It was the project location that was objectionable. Currently, the site would interface with a large section of Hawai'i Volcanoes National Park and this was seen by some members as counterproductive to the aims and goals of the National Park in Hawai'i. It was suggested that further discussion of the

geothermal proposal be scheduled at the following meeting, a motion was made and passed by a majority. It was also noted that due to problems of financial overextension in previous endorsements of conservation issues, that the Society had felt it best not to make financial commitments of this type. A further note was made regarding the limits of the Society regarding the endorsement of issues deemed of a political or hotly debatable nature.

Under announcements, Vice-President Canfield stated that we would have a plant sale after the December meeting.

Our Plant-of-the-Month Speaker was Joan Canfield who talked about the recent proposal for a damming of the Kauaiko Stream on Kaua'i. This proposal was submitted to the Society for review and Joan, currently conducting research in the Alakai Swamp on Kaua'i, reported on some of the potential effects of this project. The proposal is sponsored by Department of Land and Natural Resources, although comment was made that this sponsorship may not be wholehearted on the part of DLNR, and by Kekaha Sugar Co. The design involves flooding 250 acres of 'ohi'a forest, although it's pointed out that the effects in terms of loss of habitat would be far more extensive than 250 acres. The project was viewed by many members as shortsighted and potentially devastating to native flora and fauna on Kaua'i. Joan said she would keep the Society informed as to developments regarding this proposal and urged all individuals to communicate with DLNR on this issue.

Our Speaker of the Month was Bob Hobdy, Assistant Forester of Maui County, with DLNR, who gave a very entertaining talk on "The Offshore Islets of Maui County". Bob's talk was accompanied by an excellent slide show of Maui native flora and habitat.

Respectfully submitted,
K.E. Schlech

Minutes of the December 6 meeting

The meeting was called to order by Vice-President Canfield at 7:40. The November minutes were read and approved and there was no Treasurer's report for November. Membership Committee Chairman Asherman announced that the Society had 111 paid and honorary members, and that she had updated the membership information files, so that bills can be sent out to others.

Conservation Committee Chairman Wayne Gagne gave an update on the following topics: 1) Hanaula cattle trespassing problem - Wayne began pursuing this problem in October 1980 and several letters have been exchanged with various parties since that time. The Ombudsman was approached for assistance in obtaining a response from the State Forester, and the response was that the gates were left open by cowboys and that the cattle travel upland when the conditions are dry. The area is also accessible to pigs, hunters, and motorcyclists. All of which are further impacting the area. Currently, a confidential request has been issued by the Forester to the appropriate enforcer asking for response to this situation.

2) Palila habitat - John Giffin, State Biologist for the Division of Fish and Wildlife, has ordered that mouflon sheep and all other feral animals be removed from the area involved. The Sierra Club Legal Defense Fund has asked for a continuance of enforcement and the hunting season is currently being reconsidered. Basically, the State is not cooperating in this protection endeavor, although Forestry did sponsor the planting of some mamane trees in the area.

3) On a more positive note, the area of Queen's Beach considered in the City's General Plan for development has been, for the moment, preserved. The Queen's area was deleted from the General Plan, an option supported by Councilman Akahane. There was no Native Plants Committee report.

Under old business, rather than have an open discussion concerning the issue of the geothermal development in Kahauale'a, Joan Canfield gave a short report on the results of a panel meeting on this project. The following points, both pro and con, were presented: Pro - 1) Geothermal energy is one of the cleanest alternative energy sources. 2) The proposed location on the East Rift zone of Kilauea is the ideal location for the project, in geological terms for tapping this resource. 3) Less toxic acids are produced by natural venting in this area than in other areas. Con - 1) Safety risks related to production of acids and heavy metals during operation were cited as a potential threat to residents and agriculture. There are insufficient State regulations in effect to assure adequate control. The risks associated with volcanic eruption in the immediate project area were also mentioned. 2) The land involved is not zoned for industrial use. It is a State-zoned conservation district and has been designated as part of a biosphere reserve by UNESCO. The proximity to Hawai'i Volcanoes National Park and the possible impact on park activities is also a concern. (3) The last large population of the Adenophorus periens, an endangered fern, lies within the project area. (4) The credibility of the developers has been questioned. There is some doubt as to whether they are acting in good faith in their justification of the project and its location. (5) The existence of more suitable alternatives for power generation on the Island of Hawai'i has been suggested. Following Canfield's report, a motion was made that the Society not get involved in this issue. The motion was seconded and a hand vote was taken: 8 were in favor and 10 against. The motion was not passed. Another motion was made that the Society respond to the issue by stating an objection to the location, but endorsement of the geothermal concept. The motion was seconded and a hand vote taken. The results were 16 in favor and 1 against; the motion passed. (It should be noted that abstentions were not counted.) A request for an individual to draft the letter was made. There was no response and it was decided that as Chris Simon made the motion, she would draft the letter.

Under new business, Ron Hurov moved that the Society send a letter to the Waimea Falls Arboretum in recognition of the hard and productive botanical work that has gone on there recently. The motion was seconded and passed unanimously. Ron volunteered to write the letter.

Also under new business, a suggestion was made to set up an Awards Committee to acknowledge outstanding contributions in Botany. As this had been done before, Ray Fosberg being the first recipient, discussion ensued

as to whether the Botanical Society had a plaque to award the recipients and it was concluded that there was a plaque somewhere.

Under announcements, the good news was that Pacific Tropical Botanical Garden survived Hurricane Iwa in good shape, and that the special issue on Hawai'i published by Natural History magazine is on sale at Shop Pacifica of the Bishop Museum. Alan Holt announced that Nature Conservancy was holding an Open House December 15 from 5 to 7 pm, and that they were also sponsoring a special edition set of greeting cards which will be available at the Open House.

Elections of new officers took place and the proposed slate was voted in unanimously.

Our Plant-of-the-Month Speaker was exchanged for the geothermal discussion and our Speaker of the Month was Chris Simon who gave a fascinating talk on "The Natural History of Costa Rica and the Role of the Organization for Tropical Studies in Biological Programs in Central America".

The election results for Executive Officers of the Hawaiian Botanical Society for 1983 are as follows:

Executive Council:

President - Sy Sohmer
Vice-President - Evangeline Funk
Treasurer - Derral Herbst
Secretary - Kristen Schlech
Directors - Keith Wooliams, Isabella Abbott

Committees (Appointed by the Executive Council):

Membership - Karen Asherman (Chairman), Winona Char, Betsy Gagne, Kristen Schlech
Newsletter - Isabella Abbott (Chairman), Cliff Smith (Editor), Bill Brostoff, Mae Ikawa, Cheran Wilson
Conservation - Wayne Gagne (Chairman), Art Medeiros (Maui), Chris Simon (Hawai'i)
Science Fair - Winona Char (Chairman), Bill Brostoff, Faith Roeleffs
Native Plants - No Chairman, Carolyn Corn, Evangeline Funk, Art Medeiros (Maui), Ken Nagata, John Obata, Lani Stemmermann (Hawaii)

Respectfully submitted,
K. E. Schlech

A GUIDE TO THE FLOWERING PLANTS OF THE HAWAIIAN ISLANDS

S. H. Sohmer
W. L. Wagner
Department of Botany
Bishop Museum
P. O. Box 19000-A
HONOLULU HI 96819

The prime objective of this project, which is funded by the Irwin Charity Foundation of San Francisco, is to produce a manual to the flowering plants of the Hawaiian Archipelago within three years including both native and naturalized exotic species. The project's principal investigators (in alphabetical order) are Drs. Derral R. Herbst (Botanist, Office of Environmental Services, U. S. Fish and Wildlife Service, Honolulu), S. H. Sohmer (Chairman, Department of Botany, Bernice P. Bishop Museum), and Warren L. Wagner (Assistant Research Botanist, Bernice P. Bishop Museum). Dr. Sohmer planned the project, set the goals and is in overall charge of the effort. Dr. Wagner, hired through the auspices of the Irwin Foundation grant, and a research assistant, will be performing most of the day-to-day labor of producing the manuscript and gathering literature. Dr. Herbst has over 20 years of field experience with the Hawaiian flora and brings to the project an intimate knowledge of the ecology and growth habits of the plants treated in the manual. The interplay between authors is extremely productive and a collaborative team has been established that would be impossible to recreate with any other three participants. The project will be carried out via utilization of three primary resources: study of Hawaiian plant specimens in the Herbarium Pacificum, which is the single largest collection of Hawaiian plants in the world, gathering of literature on Hawaiian plants, and extensive field knowledge of Hawai'i.

It has been nearly 100 years since Hillebrand's classic Flora of the Hawaiian Islands was published. Since that time numerous new species have been discovered and described, yet there remains an ongoing controversy concerning the number and the delimitation of species in the Hawaiian flora. In order to make future progress in understanding and preserving the plants of Hawai'i, the people of Hawai'i and the scientific community are in critical need of a basic work that provides, in a single place, the means to identify the native and established exotic plants occurring in the Hawaiian Archipelago. A corollary to this basic need is that it is essential that it be carried out in the context of the application of uniform and recent concepts in delimiting species.

The result of this project will be a single volume manual to the flowering plants of the Hawaiian Archipelago. The book will contain keys and descriptions to the families, genera and species of plants, both native and established exotics, occurring in Hawai'i. Each species treated in the book will be provided with its accepted scientific name, Hawaiian and English common names, list of nomenclatural synonyms, literature citations for all relevant taxonomic publications, statement of geographical and ecological ranges, chromosome numbers (if available), and notes on taxonomic problems or information provided by knowledgeable individuals. Ethnobotanical information will also be provided as deemed appropriate. At least one detailed line illustration will be included for each genus, and

at the end of the text a full index to all names will be given as well as the complete bibliography.

A number of activities are directly and indirectly related to the successful completion of the project. In addition to the three principal investigators, the research assistant, Susan W. Mill, will enter text onto the Wang OIS-115-2 word processor that was purchased under the auspices of the grant. She will also gather literature for the study of each genus. The bulk of the technician's time, however, will be taken up in creating on the word processor an Hawaiian literature data bank that will allow the user to access any publication on Hawaiian botany by the use of a large number of key words. Key word categories will include taxonomic names (family, genus, species), the type of study the publication represents (evolution, for example), and geographical location. Another activity that will prove to be of great benefit to Hawai'i and the world will be the improvement of the physical condition of the approximately 78,000 specimens in the Hawaiian section of the Herbarium Pacificum and the annotation of each of these specimens examined by members of the flora project. Therefore, by the end of the project we expect that each specimen in the Hawaiian section will have been annotated, repaired (if necessary) and will be placed in appropriately labelled filing folders. Mrs. Jane Medler, Research Affiliate and full-time volunteer, has taken on a significant part of the burden of this curatorial activity.

The authors will also invite specialists on particular taxonomic groups to contribute treatments of their groups to the flora. In this way, much better and more up-to-date treatments that are the result of years of study can be presented in the book. One example of this is the planned contribution by Dr. Gerald D. Carr, University of Hawaii, of a treatment of the 33 species of the Hawaiian Silversword Alliance (Asteraceae - Madiinae). Contributions are being requested for the Cyperaceae, Euphorbiaceae, Poaceae, and Wikstroemia (Thymelaeaceae). These treatments will either be written by the specialists in the style and format of the GUIDE or the authors will adapt the treatments to that format.

Another form of invaluable contribution will be assistance from many specialists worldwide in determining the correct name for some of the exotic weed species that have been introduced here from all over the globe. The project is likewise receiving tremendous assistance from the Hawaiian botanical community particularly in the form of detailed information about populations of plants in the field obtained by years of extensive hiking throughout the islands. A number of Hawaiian botanists also have agreed to serve on an informal ad hoc committee for the project.

A number of publication, other than the single volume Guide to the Flowering Plants of the Hawaiian Islands, will result from this project. Since no new species or new nomenclatural combinations will be published in the GUIDE itself, such changes will be published as separate articles in refereed journals in advance of the publication of the book. In order to determine the correct name for each species treated in the book extensive research effort will be expended on the examination of type specimens for each name published for all Hawaiian plants species. This invaluable, but very technical information, will be published separately as an Index to the Nomenclature of Hawaiian Flowering Plants. A similar publication is also planned for the extensive data bank on Hawaiian botanical publications.

A large number of the type specimens for Hawaiian plants are stored in the Herbarium Pacificum. However, there are a significant number of types, particularly, for species described from the early exploring expeditions, that are stored at other institutions. In order to properly complete the nomenclatural portion of the project, it will be necessary to travel to a number of other institutions to examine and photograph for the Herbarium Pacificum the type specimens housed at each. Additional travel funds will be requested from the National Science Foundation for this aspect of the project. Some of the herbaria that must be visited are the Royal Botanical Gardens (London) for specimens that were the bases for the species described by Hooker and Arnott; British Museum (London); the Gray Herbarium (Cambridge, Massachusetts) and the Smithsonian Institution (Washington, D.C.) for species described by Asa Gray; The Paris Museum for Gaudichaud specimens; The Botanical Museum (Goteborg), the University of Lund, and the Natural History Museum (Stockholm), Sweden, to examine Carl Skottsberg's collections. In addition several other institutions should be visited to search for important Hillebrand collections that were not kept at Berlin, the majority of which were destroyed during World War II.

The products of this project, the Guide to the Flowering Plants of the Hawaiian Islands, Hawaiian bibliography on plant publications, and the nomenclatural index, will be of great use in conservation, in education, the scientific study of Hawaiian plants and animals, studies of evolution, and for everyone concerned with the people of biota of the Pacific Basin.

NOXIOUS WEEDS IN HAWAII

We have had a grand total of two responses to the request originally printed in the 1980 issue of the Newsletter. You may remember that Dr. Abbott had suggested that it would be very useful if the Society produced a list of weeds which members consider to be the most noxious in the state. We still feel that the production of such a list is important and we again invite Society members to contribute their nominations.

If you wish to confine your list to any particular island you may do so but please make sure that the island is clearly identified. You may submit different lists for different islands. You may use common or scientific names. If you use common names please try to be as unambiguous as possible.

This little exercise should only take a few moments.

The good news is that various state and federal agencies are in the final stages of reaching an agreement on a cooperative research program to study potential biological control agents of Hawaiian forest pests.

HAWAIIAN BOTANICAL SOCIETY,
c/o DEPARTMENT OF BOTANY,
UNIVERSITY OF HAWAII,
HONOLULU HAWAII 96822

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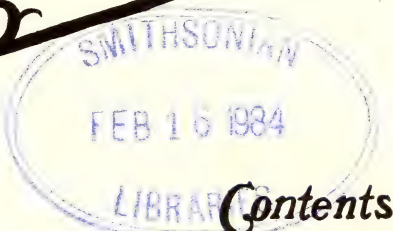
Newsletter

Hawaiian Botanical Society



VOLUME 22

1983



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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

OFFICERS OF THE HAWAIIAN BOTANICAL SOCIETY 1983

Executive Council

President: Dr. S. Sohmer, Bishop Museum
Vice-President: Ms. E. Funk, University of Hawaii
Treasurer: Dr. D. Herbst, U. S. Fish and Wildlife Service
Secretary: Ms. K. Schlech, Bishop Museum
Directors: Mr. K. Woolliams, Waimea Botanic Gardens
Dr. I. Abbott, University of Hawaii

Committees (appointed by the Executive Council)

Membership: Ms. K. Asherman, Chair
Ms. B. Gagne
Ms. K. Schlech
Ms. W. Char
Newsletter; Dr. I. Abbott, Chair
Dr. C. Smith, Editor
Mr. W. Brostoff
Ms. C. Wilson
Ms. M. Ikawa
Conservation: Dr. W. Gagne, Chair
Dr. C. Simon
Ms. L. Stemmermann, Hawaii
Mr. A. Medeiros, Maui
Science Fair: Ms. W. Char, Chair
Mr. W. Brostoff
Ms. F. Roeloffs
Native Plants: Dr. C. Corn, Chair
Mr. K. Nagata
Ms. E. Funk
Mr. J. Obata
Ms. L. Stemmermann, Hawaii
Mr. A. Medeiros, Maui

Letter to the Editor:

Hawaii is a veritable evolutionary showcase. The Hawaiian Finches (formerly Hawaiian Honeycreepers) offer a striking example of adaptive radiation that far exceeds that of the Galapagos Finches which provided Darwin with much of his inspiration. Fruit flies, land snails and many groups of plants and insects in Hawaii offer comparable, if not more spectacular, examples.

The semitropical forests of Hawaii, like tropical forests everywhere, are threatened with destruction. These forests provide habitat for thousands of species. Currently twenty species of birds are endangered in Hawaii and as many as 900 plants have been proposed as either endangered or threatened. More importantly, entire communities may be eliminated.

Increasing human population, with its attendant urban sprawl, clearing of land for crops, cattle pasture and other uses as well as the presence and continued influx of exotic plants and animals are the biggest threats to Hawaii's native plants and animals.

The Hawaii chapter of The Nature Conservancy (TNC) recently initiated a Hawaii Forest Bird Project. They have utilized recently acquired information to identify the most valuable habitat for endangered forest birds and they are now seeking to preserve these lands in as close to their natural state as possible.

We have all worked in Hawaii and feel that TNC's effort may be the last hope for saving these upland forests from uses which are inconsistent with the long-term survival of Hawaii's forest communities. TNC presently has a commitment to acquire a conservation easement in perpetuity on 5230 acres on Maui. The cost of this easement is \$60.00 per acre. Because of our interest in Hawaii's native flora and fauna and our belief that TNC's conservation efforts will provide a real opportunity to make a difference and are based on solid scientific information, we have pledged to protect at least one acre of this land.

We are writing this letter in the hope that others will pledge a similar amount. Protection of these upland forests (home of the Maui Parrotbill, Crested Honeycreeper, Maui Nukupuu and Maui Akepa) will protect hundreds of other species and the integrity of several communities. With these communities intact man will keep open a window on evolutionary processes that might otherwise be closed forever.

Persons interested in contributing toward the acquisition of the Waikamoi Reserve on Maui are asked to send their tax-deductible contributions to: The Nature Conservancy of Hawaii, 1024 Nuuanu Avenue, Suite 201, Honolulu, Hawaii 96817. Please state that your contribution is for the Waikamoi Reserve.

A group of concerned natural scientists

Minutes of the January 3, 1983 Meeting

President Sohmer called the meeting to order at 7:30 with some opening remarks for the new year. Two of our guests were Warren Wagner and Susan Mills. Warren has recently arrived in Hawaii from the Missouri Botanical Garden where he was studying the family Onagraceae. He has joined the staff at B.P. Bishop Museum where he will be working on the Hawaii Flora Project. Susan, recently enrolled at the University of Hawaii, is working part-time for the Herbarium.

The December minutes were read and approved and the Treasurer's report is as follows:

Balance as of October 31.....	\$1,932.23
Receipts.....	122.50
Expenditures.....	4.55
Balance as of November 30.....	2,050.18
Receipts.....	-..
Expenditures.....	8.97
Balance as of December 31.....	\$2,041.21

The Membership Committee reported that bills will be going out soon. The Society has several new members.

There was no Newsletter Committee report. (Dr. Abbott is in Chile.)

The Conservation Committee reported on several items, the highlights of which are as follows:

1) A reminder that the Endangered Species Act is still in trouble; although it has been reauthorized by Congress, the projected budget is \$11 million less than last year, a decrease from \$27 million to \$16 million.

2) Senator Inouye's office has proposed \$250,000 be allocated to the TriFly Eradication Program, one which involves the use of several methods of extermination, including the use of insecticides on all of the islands. The project will cover a 15 year span and over this time the impact on both the pollinators and surrounding environment are not known.

The Science Fair Committee presented an overview of the 1983 Hawaiian Science and Engineering Fair schedule, and a list of awards given by the Hawaiian Botanical Society in the Intermediate Divisions. Some discussion was held concerning the monetary awards, and it was suggested that it be brought up for vote at the next meeting.

The Native Plants Committee reported that they held a meeting to discuss activities for 1983.

There was no old business or new business. There was no Plant of the Month speaker. The Speaker of the Month was John Ford, who gave an enlightening talk on the freshwater fauna of Hawaii, particularly those species having life cycles which span both fresh and saltwater habitats.

Respectfully submitted,
K.E. Schlech, Secretary

Addendum to January 3 Minutes
Native Plant Committee Report
Carolyn Corn, Chairman

Native Plant Committee priorities for this year are threefold:

- 1) Periodic hikes or outings are to be arranged by Evangeline Funk.
- 2) Compilation of data on rare plant taxa is to include the continued soliciting of Hawaiian Botanical Society field data forms by hikers. Observations made by various state, federal, county, and private groups will be included when available.
- 3) Native plants, particularly the more showy ones, are to be grown. These should be available on a limited basis for occasional distribution. John Obata has been doing this in the past and plans to continue. Hopefully, others with green thumbs can be enticed to help out. Distribution should be limited to those people or organizations most likely to successfully grow these plants and where they can be best exhibited for a number of people to appreciate them.

Minutes of the February 7, 1983 Meeting

Vice-President Funk called the meeting to order at 7:30, as President Sohmer was in New Zealand at the Pacific Science Congress. The January minutes were read and approved, and the Treasurer's report was as follows:

Balance as of January 1.....	\$2,041.21
Receipts.....	180.00
Expenditures.....	16.64
Balance as of January 31.....	\$2,205.07

Derral Herbst also submitted a copy of the Treasurer's Annual Report for 1982, which has been audited by W. Busch.

The Newsletter Committee reported that the first back issue of the Newsletter was out and copies could be picked up at the end of the meeting.

There were no Native Plant or Conservation Committee reports. (Chairmen Corn and Gagne were both in New Zealand.)

Under old business, Winona Char made a motion that the Society allocate \$80.00 for monetary awards at the Science Fair, as approved by the Executive Council. The motion was seconded and passed unanimously.

New business included the announcement of plant exchange month in March and a plea for help with refreshments. Faith Roeleffs talked about the March 12 outing at Makiki Environmental Center. This day trip will include the Ethnobotanical Garden, the Palm Garden, the Bamboo Stands and many other areas of interest. All are welcome to attend.

As Plant of the Month Speaker, Winona Char gave a very entertaining talk on her thesis topic - Sesbania.

Our Speaker of the Month was Dr. Gilmore, who discussed the TriFly Eradication Program and the several possible avenues of approach to ridding the islands of all three species of fruit fly (Oriental, Mediterranean and Melon). A combination of techniques is proposed, including bait traps, release of sterile males, and application of insecticides.

Respectfully submitted,
K.E. Schlech, Secretary

Minutes of the March 7, 1983 Meeting

President Sohmer called the meeting to order at 7:30. Several guests attended the meeting, among them many recently arrived phycology graduate students at the University of Hawaii, who were introduced to the Society by Dr. Maxwell Doty.

The February minutes were read, amended and approved. The Treasurer's report was read as follows:

Balance as of February 1.....	\$2,205.07
Receipts.....	497.50
Expenditures.....	716.38
Balance as of February 28.....	\$1,986.19

A Conservation Committee report was given by Wayne Gagne, who briefed the Society on some of the bills pending before the Hawaii State Legislature:

- 1) The tax checkoff for wildlife is up for approval, being the same tax option as political campaigns.
- 2) The instream uses of water; if this bill is passed, the Department of Land and Natural Resources will have the authority to protect streams from channelization and water

diversion, especially on the outer islands, where this type of dewatering could seriously affect surrounding environments.

3) Coastal Development; this bill would insure protection of open spaces which are less than 300 feet from the water or shore line.

4) Geothermal Energy; if this bill passes, geothermal energy development activity will be permissible in areas that are conservation districts. Currently, certain other restricted activities (e.g. gardening) are allowed within these conservation boundaries and this bill attempts to include geothermal-related activity as another 'extra-curricular activity'. Some discussion by the membership was held.

Steve Montgomery, member of the Conservation Committee, also made several announcements. Steve is now the legislative assistant to Senator Chang, a position that keeps him up-to-date on conservation issues that are pending in the House and Senate. Steve endorsed Wayne's comments of the tax checkoff, and announced that March 20 was the beginning of National Wildlife Week and this year's theme is 'Public Lands Belong To All Of Us'. The organization has designed a poster for this year's theme and Steve requested that the Society consider donating money to help defray printing costs. Sy Sohmer accepted the request and stated that the Executive Council would review past donations to National Wildlife Society and make recommendations for an appropriate amount.

Evangeline Funk, member of the Native Plants Committee, announced that the field trip scheduled for March 12 would begin a 9:00 am, and she briefly outlined the trip's itinerary.

Karen Asherman, chairman of the Membership Committee, reported that the Society now has 115 regular members and 22 honorary members. The President read correspondence from Lucy Cranwell Smith, a Society member for many years and one of the participants in the Hawaii Bog Survey, who generously donated \$100.00 to the Society. Bill Busch and Paul Weissich also donated a gift of \$25.00 to the Society. The members voted that they each be written a letter of appreciation.

Cheran Wilson, member of the Newsletter Committee, reported that the next issue (1981) of the Newsletter had been pasted up and was ready for printing. The Newsletter is going to publish an article with accompanying photos of the new botany graduate students at the University of Hawaii. Dr. Isabelle Abbott asked the members to return the forms she distributed for the article on noxious weeds.

Winona Char, Chairman of the Science Fair Committee, reported that things were running smoothly and there were no new developments to present.

Under old business, the President announced that the Executive Council had drafted an amendment to the Constitution allowing for the routing of all financial matters through the Council prior to presentation before the membership for vote. It was felt that this would eliminate unnecessary discussion at the general meetings, and allow the Executive Council to review the financial status of the Society, as well as the appropriateness of the specific request, in order to better inform the membership on the precedents and policies germane to such issues. It was further felt that this approach would eliminate some of the controversy associated with certain political or conservation issues in which the Society took financial involvement. Dr. Abbott made a motion to vote on the inclusion of the amendment, but the motion was tabled to allow the membership a month's time after the announcement before voting takes place, as recommended by the by-laws.

Under new business, Steve Montgomery's request for a donation to National Wildlife Federation was reintroduced and discussed. The request asked for \$200.00 to cover the balance of the printer's bill. Past donations have ranged between \$50.00 and \$200.00 (to the Conservation Council) and the monies were donated from the general membership funds. As the monies were needed by March 27th, before the next general meeting, the President acknowledged that the Executive Council would act immediately on the request.

The geothermal issue was again raised. A motion that Hawaiian Botanical Society send a letter to the chairmen of the appropriate committees in the Legislature expressing the Society's opposition to geothermal activity in areas designated for conservation was seconded. A vote was taken, with 30 in favor, 4 opposed, and 2 abstentions. Considerable discussion preceded the vote, the highlights of which were that 1) geological areas such as some portions of the proposed site were not suitable for anything but geothermal development and that the pristine areas were not the areas that seemed to be in question, 2) that birds and other organisms which may utilize these particular areas would be losing habitat space, 3) that this proposal should never have gone through as a change in the regulations on Conservation District use authorization. The President concluded discussion by appointing Cheran Wilson to draft the letter. Keith Wooliams, Director of the Society, made the constructive comment that once the Newsletter is brought up to date that it can provide a viable, subtle vehicle for comment on this type of issue and this approach was supported by Dr. Abbott, Chairman of the Newsletter Committee.

The Plant of the Month Speaker was Marie Bruegmann, a graduate student from the University of Michigan, who is spending some time in Hawaii investigating the fern Marsilea in the Koko Head Crater.

Our Speaker of the Month was Dr. Dieter Mueller-Dombois, who presented another installment on the dieback phenomenon, entitled Stand Level Dieback in New Zealand Forest and the Theory of Cohort Senescence.

March was also Plant Exchange Month.

Respectfully submitted,
K.E. Schlech, Secretary

Minutes of the April 4, 1983 meeting

President Sohmer called the meeting to order at 7:30. The March minutes were read, amended, and approved. Derral Herbst gave the Treasurer's report as follows:

Balance as of March 1.....	\$1,986.19
Receipts.....	353.50
Expenditures.....	103.38
Balance as of March 31.....	\$2,236.31

The Membership Committee announced that it had plans to draft a letter to non-members outlining the activities and membership information of Hawaiian Botanical Society to be distributed to groups which may be potential members.

The Conservation Committee reported on several issues, the highlights of which follow:

- 1) The geothermal bill is still pending.
- 2) Dr. Lamoureux explained the pathway of the tax checkoff bill as it moves through the House to the Senate. Two committees were formed to review the bill to assign specific areas for use that would have low effect, but the revision was torn apart in the House, and the bill has now gone back to the drawing board.

There was no Native Plants Committee report.

The Newsletter Committee reported that the 1981 issue was at the printers and the 1982 issue was in the paste-up stage.

Under old business, the President announced that a letter, composed by Cheran Wilson, had been sent to Senator Cayetano's office, outlining the position of the Society regarding the exploitation of geothermal energy in areas designated as conservation districts. Copies of the letter were available for any interested members.

The President announced that the Society had donated \$100.00 to the Conservation Council for the National Wildlife Federation poster. The last item under old business was the announcement of

the up-coming vote on the amendment to the by-laws which, if passed by the membership in May, will be incorporated as follows:

All requests for expenditures by Hawaiian Botanical Society must be discussed at a prior meeting of the Executive Board and submitted for approval at the next meeting of the Society.

Under new business, the President announced that a letter of thanks had been sent to Mrs. Lucy Cranwell Smith in response to her generous donation to the Society.

Our Plant of the Month Speaker was the President, who talked about Charpentiera (Amaranthaceae) in Hawaii.

Our Speaker of the Month was Ms. Jacquelin N. Miller, who is the Associate Specialist at the U.H. Environmental Center. Ms. Miller presented a very informative talk on the processes involved in the analyses of a Environmental Impact Statement and the different analyses such a document receives as it undergoes review.

Respectfully submitted,
Kristen Schlech, Secretary

Minutes of the May 2, 1983 Meeting

The meeting was called to order by President Sohmer at 7:30. He introduced Dr. Bruce Haywood, a visiting micropaleontologist from New Zealand. Dr. Haywood is also an expert on the history of the Kauri Pine resin industry and the early logging techniques in New Zealand. The April minutes were read and approved. Derral Herbst gave the Treasurer's report as follows:

Balance as of April 1.....	\$2,236.31
Receipts.....	94.00
Expenditures.....	259.45
Balance as of April 30.....	\$2,035.17

There was no Conservation Committee report or Native Plants Committee reports. The Membership Committee reported that we have 138 members in good standing. The Newsletter Committee reported that the next edition of the Newsletter is on the way. The Science Fair Committee Chairman, Winona Char, announced the winners of the Hawaiian Botanical Society awards and the recipients of our traveling plaque. The winners of the plaque were Sandra Soong and Dina Ueoka of Baldwin High, Maui, who investigated the effects of environment on seaweed distribution. A summary of the winners follows:

Intermediate Division:

- 1st - Michael Tom, Kawanānakoā Intermediate (grade 7)
"Does acid rain affect water loss through the stomata of bean plants?"
- 2nd - Gloria Chen, Hawaii School for Girls (grade 8)
"Can Ulva lactuca be used as fertilizer?"

Senior Division:

- 1st - Sandra Soong and Dina Ueoka, Baldwin High (grade 10) "Effects of environments on seaweed distribution."
- 2nd - Claire Kobayashi and Evan Koizumi, Iolani School (grade 9) "Calcium propionate as a bread mold retardant."

Under old business, a motion was made to vote on the approval of the amendment to Article V of the by-laws, as stated at the previous meeting. The motion was seconded and a unanimous vote in favor was counted.

The President and the Society thanked Karen Shigematsu for her generous donation of time and energy as refreshment chairman. Karen has worked on the refreshment committee on and off for several years and graciously offered to serve again this year in spite of the fact that she had no help. This job will be open again as of October 1 and a volunteer is requested for refreshments for the fall meetings.

Under new business, Derral Herbst submitted several proposals related to finances which are as follows:

- 1) That a motion be made to authorize the Treasurer to consolidate the Society's accounts as requested of the Executive Board.
- 2) That a motion be made requesting \$300.00 from the Society's General Fund to be donated to the Maui Zoo and Botanical Garden, the Pacific Tropical Botanical Garden, and the Wau Ecology Institute.
- 3) That a motion be made requesting \$300.00 from the Marie Neal Fund to be given to the Nature Conservancy for the purchase of 5 acres of conservation easement on Waikamoi Reserve of Maui.

Motions on the first two proposals were made, seconded, and a unanimous vote in favor (with two abstentions) was counted. The third proposal was discussed, and Herbst was asked how much money was available in the Marie Neal Fund, to which indicated several thousand. Evangeline Funk suggested \$900.00 be donated for 15 acres and after more discussion Charlie Lamoureux suggested a \$1,500.00 donation for the purchase of 25 acres. A motion that this amount be requested from the Marie Neal Fund was made and a unanimous vote in favor (with two abstentions) was counted.

Under announcements, the death of one of our charter members was noted. Dr. D.M. Weller, plant anatomist and charter member of the Hawaiian Botanical Society, passed away earlier this year.

Also under announcements, a request for plant pots was made by George Linney. Anyone having spares is asked to donate them at the plant exchange next month.

Hurricane Iwa was the topic of our Plant of the Month Speaker, Dr. C.H. Lamoureux. He showed some excellent aerial photographs of the hurricane damage on Kauai and talked briefly on the vegetation types most affected by the hurricane.

The topic of our Speaker of the Month, Chipper Wickman, was Brighamia (Campanulaceae) in Hawaii. Chipper narrated a fascinating presentation on the harrowing adventures of stalking and cultivating the rare Brighamia on Kauai. The persistence and perserverance of Chipper Steve Perlman (of Pacific Tropical Botanical Garden) culminated in one of the few real success stories involving rare and endemic Hawaiian plants. It appears that Brighamia has been saved!

Respectfully submitted,
Kristen Schlech, Secretary

GOTEBOG BOTANIST WORKING AT BISHOP MUSEUM

Dr. Bo Peterson, Head Curator, Botanical Museum, University of Goteborg, is spending two months at the Bishop Museum collaborating with the staff of the Herbarium Pacificum on the Guide to the Flowering Plants of the Hawaiian Islands Project. Dr. Peterson was born in Varberg, Sweden, in 1918 and took the American equivalent of a baccalaureate degree from the University of Goteborg and the Ph.D. from Lund. His thesis concerned the revision of Struthiola in the Thymelaeaceae. Dr. Peterson was a student of Dr. Carl Skottsberg at Goteborg. He was an Assistant at the Botanical Department of the Natural History Museum in Stockholm, 1946-1950, and the Chief Assistant at the Botanical Garden at Lund, 1951-1959. In 1960-62 he was Curator at the Botanical Garden at Goteborg and Director of that institute from 1963-65. He has been Head Curator at the Botanical Museum since 1965. His specialty is the Thymelaeaceae and he is working on the genus Wikstroemia at the Bishop Museum. He will be in Honolulu until the end of January, 1984.

A POSSIBLE NEW PATHOGEN AFFECTING METROSIDEROS IN HAWAII

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About 20 years ago, on a visit to Hawaii Volcanoes National Park, Hawaii, I was asked by Mr. Garrett Smathers, of the Park staff, if I could suggest the reason for the poor condition of a tree of Metrosideros collina at the Puhimau Crater parking area on the Chain-of-Craters Road. I looked at the tree which showed strong yellowing of the leaves and considerable loss of leaves. No convincing cause for this condition was obvious to me, but I suggested that it might be due to volcanic heat in the ground or to compaction of soil from trampling. Quite a few dead trees were observed in the area of this section of the road, but the nearest known "hot-spot" or fumarole area was somewhat lower down along the road. Later I was able to examine an infra-red aerial photo on which the heated areas were visible. There was no evidence of heat in the area where the dead or sick trees were observed.

Sometime later I again visited the Puhimau Crater area, the amount of time elapsed I failed to record, as I had no idea I would become interested in it. The tree that I had looked at earlier was dead, but had not yet lost its bark or all of its dead leaves. One curious occurrence caught my eye. Black lumpy excrescences, presumably fruiting bodies of a fungus, were pushing out of cracks in the bark of the tree. I collected a few of them and gave them to a mycologist, who said they were too immature for identification. On this visit an area of dead and dying 'ohi'a lehua (Metrosideros collina) trees, just above and across the road from Puhimau Crater caught my attention. In about 1 hectare of Metrosideros forest most of the trees were dead. Those in the central area had obviously been dead for some time, had lost their leaves and were losing their bark. They bore fruiting bodies of Hypoxylon uniapiculatum (Penz. & Sacc.) J.H. Mills, a wood-destroying or perhaps weakly parasitic fungus, but none of the lumpy black fruits seen on the tree near the crater. A few trees around the periphery were obviously recently dead, still retaining their leaves and had the same sort of black lumps, mentioned above, pushing out of cracks in their bark.

I decided to tag some still living trees and record their condition picking a small area between the road and the crater rim, similar to the site of the first tree examined, but not subject to trampling or pig rooting. Ten trees were tagged with numbered green plastic tags tied to limbs with copper wire.

A general look at the Metrosideros in the area showed that most of the trees were not of maximum size, presumably not very old, but there is no obvious means of determining age of tropical trees without annual rings. It was further noticed that almost all trees had some dead twigs, even though the other parts looked

healthy. The sample of ten trees included ones with varying amounts of dead growth, from almost none to trees in poor condition. My intention was to reexamine these trees at any time I revisited the Kilauea area, and see what developed.

The trees in this area are, on the occasions of eruptions, subjected to sulphur-dioxide fumes and may receive some injury, especially if the eruptions occurred when there was tender young growth. Mrs. C.K. Wentworth, resident of the Volcano area, told me that the trees in the hectare mentioned, had shown signs of decline since 1956 or 1957, but it was not conspicuous enough that I had noticed it before. Signs of extensive pig-rooting were seen later in this area, but were not recorded on the 1963 examination.

In a number of drives along the old Chain-of-Craters Road, a considerable number of dead trees were seen, mostly scattered among healthy ones. At several places dead trees were examined. Of those that had obviously been dead only a short time, that retained their bark and at least some dead leaves, most showed the black fruiting bodies. A large dead tree was examined in Kipuka Nene, on the Hilina Pali Road, and as usual, the fungus was present, as also on trees to the north of the Chain-of-Craters, on the "Escape Road".

In the area mentioned above, across the road from Puhimau Crater, but not directly across the middle of the hectare of dead trees, two transects, each including 100 trees, were walked, and all trees over 4 m tall were rated as healthy, badly diseased, or dead. On one transect, there were 32 dead or badly diseased trees out of 100, on the other 28. Down the road, just above the Koko'olau Crater, two other similar transects were walked. In one there were 23 affected trees, 10 of them dead, in the other 15 affected, 5 of them dead. These counts were made in March 1964. Later, in 1978, a more extended search was made for trees exhibiting the fungus. Dead trees were examined wherever found, on all the roads in all directions from Kilauea Crater, and around it affected trees were found in the just beyond the Park Residence area on the Crater Rim Road, also at the Kilauea Iki Lookout, and along the upper part of the Chain-of-Craters Road, and down as far as the Hilina Pali Road intersection. No affected trees were found on the road toward Kona, nor on the road to, or in, Kipuka Puaula, nor on Mauna Loa Strip Road, nor in the Golf Course area, nor on the road to Hilo. Guided by Mr. Winston Banko, a day was spent in a large area of dead and dying *Metrosideros* and other trees in the Upper Olaa Forest Reserve. Many dead and dying trees were examined, but no signs of the fungus were found. This seemed to be a typical area of "ohi'a dieback", on relatively level or gently sloping wet ground. Other fungi were seen, but not the one described above and common on the trees in the drier, better drained forest below the caldera. In my opinion, the trees in the two areas, the Chain-of-Craters area and the Olaa Forest Reserve, are affected by different conditions, though in both areas the result is death of trees.

Though attempts were made to identify the fungus that produced the hard black fruiting bodies, for a number of years no mycologist that saw them would hazard an opinion as to the family to which this fungus belonged. Finally, Dr. Clark Rogerson sent them to Dr. Margaret Barr Bigelow, who suggested the genus Endothia and that I might try Dr. Martha K. Roane, who works on Endothia. Dr. Roane concluded after examining a considerable series of collections, concluded that it was a new species of a pyrenomycete of the genus Diaporthopsis Fabre. We eventually submitted a description and discussion of this fungus and its occurrence and host, naming it Diaporthopsis metrosideri. Its morphology is fully described in Mycologia 75:163-166, 1983. There is in the above paper, a cautious suggestion that this fungus might be pathogenic, but a final decision on this was left for future experimental work.

I am personally firmly convinced that it is a parasite because of the consistent appearance of its fruiting bodies shortly after the death of the host tree. How the spores are transmitted from one tree to another is not obvious. It may be that conidiospores are formed, as was demonstrated in culture by Dr. Clark Rogerson, of the New York Botanical Garden (Roane and Fosberg 1983, p. 164), on a presently unknown substrate, and that these infect the Metrosideros trees. This conidial stage fits the imperfect genus Phomopsis. In any event, the fungus has managed to infect trees of very different sizes and presumably different ages, in a rather dry, well-drained forested site on rather young lava in an area quite a few square kilometers in extent, between 2500 and 4000 feet elevation on the south slope of Kilauea Volcano, in Hawaii Volcanoes National Park, on the Island of Hawaii.

A sample of 16 marked trees in the small study area between the Chain-of-Craters Road and the rim of Puhimau Crater, were repeatedly revisited (11 times for most of them). Ten were followed through until either dead (7) or still alive and healthy (3). Of the dead ones, five produced Diaporthopsis fruiting bodies, all while retaining at least some dead leaves and intact bark. The other two dead trees had no obvious fruiting bodies and the cause of death was not apparent. The other six trees disappeared or their tags disappeared. In 1968, overzealous park employees cut down at least 13 trees in the study area. The six missing trees may have been cut at that time. The five tagged trees definitely infected with Diaporthopsis metrosideri showed no very obvious symptoms prior to death, except for an unhealthy-looking yellowing, reddening, or mottling of leaves, and partial loss of leaves. There seems to be no correlation between the fungus infection and the death of a few or many twigs and small branches, or death of tips of leading shoots. These manifestations seemed to be equally present on most trees, infected or not, and not to be precursors of death. Both the proportion of the tagged sample infected, and the proportion of all trees in the study area indicate a very high incidence of infection in the area. Observation of various localities in the

general area below the south rim of Kilauea caldera suggest a very irregular, but locally quite high incidence of infection. Areas of dead trees are not necessarily areas of this disease, as fires and lava flows are in some places obviously responsible for mortality. The size of trees dying from the fungus varies from 6 or 8 m to 20 m tall, 15 cm dbh to 40 cm or more. The high incidence of infection suggests that the fungus poses a serious threat to Metrosideros collina in the very well-drained moderate lava flow slope habitat. I can only suggest a serious, professional phytopathological study, continued observation of the area, and search for the disease over a wider area. After this paper was read at the symposium, I had, on my return through Hawaii, opportunity to make a further visit to the Kilauea area and to try to relocate the marked trees. Construction of a new parking area and viewing platform at Puhimau Crater, with rerouting of the road, made it impossible to relocate the marked trees, if indeed, any of them are still standing. Most of the patch of dead trees described above has been cut to reroute the road. Several trees with Diaporthopsis fruits were seen in the vicinity and at the Kilauea Iki parking area.

The range of the fungus was extended by the discovery of an area of open Metrosideros forest with many dead trees at Volcano Village, on the highway toward Hilo at 3850 ft. elevation. Most of the dead trees, that still retained their bark, showed Diaporthopsis metrosideri fruits. In several such trees, dead above and with fungus, have on the lower several meters of their trunks, living epicormic branches or sprouts, a condition not noticed before. This extends the range of the fungus by a number of kilometers, and into a somewhat wetter phase of the forest. The ground here was covered by a deep mat of the introduced Kikuyu grass Pennisetum clandestinum.

Editor's Note

In a recent paper M. E. Barr has transferred Diaporthopsis metrosideri Roane & Fosberg to Endothia metrosideri (Roane & Fosberg) Barr.

Barr, M. E. 1984. On Diaporthopsis metrosideri. Mycologia. 75: 930-931.

A RECORD OF NEPHROLEPIS MULTIFLORA FROM NIHOA ISLAND,
Northwestern Hawaiian Islands

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Nihoa Island is one of the two large high islands (Necker being the other) in the Northwestern Hawaiian Islands (NWHI: those Hawaiian islands north and west of Kaua'i and Ni'ihau). As such, it supports a biota with a number of unique species, including four endemic species of plants. These include Pritchardia remota, the Nihoa lo'ulu, Amaranthus brownii; Schiedea verticillata; and Sicyos nihoaensis (Christophersen and Caum 1931, St. John 1970). The island is about 63 ha in area, rising to 273 m, with an average south facing slope of 45° (Palmer 1927). The south coast consists of low (10-20 m) cliffs skirted by rock benches and one nearly inaccessible beach backed by 15-25 m cliffs. The east, west, and north coasts are sheer cliffs. The vegetation, excluding the lo'ulu, is low, averaging less than 0.5 m in height, and consisting mostly of three shrub species: Sida fallax, Solanum nelsoni, and Chenopodium oahuense, and the grass Eragrostis variabilis. Herbst has made two visits to Nihoa to study its plants (Herbst in Clapp, et al. 1977). Conant has collected data on the vegetation during a long term study of the island's two endemic land birds, the Nihoa Finch (Drepanidinae: Telespyza ultima) and the Nihoa Millerbird (Sylviinae: Acrocephalus familiaris kingi). Herbst (in Clapp, et al. 1977) noted that 25 species of vascular plants are known to have grown on Nihoa. Several species are rare, some being known from a single collection or sighting. Magnusson (1942) published a list of lichens and Conant collected algae (to date unidentified) from freshwater seeps. During 1980 and 1981, Conant spent nearly six months living on Nihoa, making extensive observations of the island's biota, including notes on the distribution, abundance and phenology of the vegetation. On the morning of 14 June 1981, Conant encountered a fern during a bird census. The plant was about 3 m from the crest of the ridge between Miller and West Palm Valleys on the west face of the ridge. It was about three quarters of the way up the ridge (about 213 m elevation) and slightly northwest of a prominent volcanic dike that crosses the crest of the ridge. Conant collected fertile fronds on 3 July 1981 and sent them to Herbst, who identified the fern and later deposited the specimen material at the B.P. Bishop Museum (accession no. 1982.357). Dr. Charles H. Lamoureux confirmed Herbst's identification and advised that

the correct name of the fern was Nephrolepis multiflora (Roxb.) Jarrett ex Morton.

The fern patch was quite small, about one m in diameter with most fronds about 20-30 cm in length. Many of the fronds were fertile and the plants appeared vigorous. Located near a ridge top, the fern undoubtedly is exposed to almost brisk trade winds as well as the low moisture conditions typical of Nihoa (annual rainfall is estimated at about 75 mm). The plants were confined to a depression in the rock where some soil may have accumulated in this otherwise barren, rocky area. Once the plant became established, its presence probably accelerated soil accumulation and retarded evaporation of moisture. It appeared that the patch had completely filled the depression at the time and there were no rhizomes spreading beyond the edges of the depression. In the six months Conant spent on Nihoa, this was the only patch of the fern found in spite of constant searches of the island's terrain for individuals or colonies of the rarer plant species. It seems most likely that fern spores reached Nihoa transported by wind rather than by birds or by accidental or intentional introduction by humans, although it is impossible to be sure. According to Lamoureux (1982), Nephrolepis multiflora is usually called Nephrolepis hirsutula (Forst.) Presl in the Hawaiian literature, and it is incorrectly listed as such in Herbst's (1931) Checklist of the Vascular Plants of the Northwestern Hawaiian Islands. It is an exotic species; the first known Hawaiian collection was made in 1923 on O'ahu by Topping (Lamoureux 1982). Lamoureux also reported that this fern is now abundant and found on all eight of the main Hawaiian Islands. This paper constitutes the first record on N. multiflora from the NWHI, and it is the first record of a naturalized fern from any of the NWHI.

We would like to thank the Office of Research Administration and the Sea Grant Program of the University of Hawaii, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service for partial support of this research.

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GIFTS RECEIVED

The Society gratefully acknowledges the receipt of financial donations from the following members.

William Bush
Loren Sill
Lucy C. Smith
Richard F. Smith
Paul Weissich

The generosity of these members is greatly appreciated.

We encourage everyone to donate to the Society in order that we may support worthy botanical programs and causes in the Islands.

Their generosity is a significant benefit to the Society. Thank you.

HAWAIIAN BOTANICAL SOCIETY

Membership Dues

Regular	\$7.50
Student	\$4.00
Family	\$10.00
Life	\$100.00 (payable one time only)

Dues are payable annually preferably during December of the year prior to subscription. Life memberships are available to individuals only. Contributions, which are tax free, are welcome.

THE MELBOURNE HILLEBRAND COLLECTION OF HAWAIIAN PLANTS

Carolyn A. Corn
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Dr. Wilhelm Hillebrand, a Prussian physician and amateur horticulturalist, travelled to Hawai'i in 1851 in search of a climate suitable for his bad health. During his 20 years in Hawai'i, he became director of Queen's Hospital and personal physician to the royal family. Many of his garden plantings on Vineyard Street are growing today in the Foster Botanical Garden. He also collected, dried, and identified plants found on hiking trips or brought to him by friends. When he returned to Germany in 1871 he took these dried plant specimens with him and began to write a flora of the islands. His book "Flora of the Hawaiian Islands" was published in 1888, two years after his death.

In his flora, he described many new taxa based upon these dried plants. These "type" plants are particularly important when one is referencing plants for their proper identification and serve as "the source" specimens for that species description. Upon Hillebrand's death, his specimens were bequeathed to the Berlin-Dahlem Museum, which was destroyed and burned in the World War II in an allied bombing raid. Only plant duplicates and/or plants on loan to other herbaria survived.

Dr. David Churchill, director of the Royal Botanic Gardens and Government Botanist of Victoria, visited Hawaii in 1973 as part of the Captain Cook Hawaii Bicentennial. He surprised the Hawaiian community by telling of a "duplicate collection" of Hillebrand's plants in Melbourne. He informed us that Dr. Hillebrand collected plants in Australia for about three months with an old school friend on his way to Hawaii in 1851. His school friend, although trained as a pharmacist, became a renowned botanist with the title of Baron Sir Ferdinand von Mueller. As the first director of the Royal Botanic Gardens and Government Botanist in Melbourne, Baron von Mueller corresponded and received plant specimens from various expeditions and islands throughout the Pacific until his death in 1896 (Honolulu Advertiser, 1979). He and Dr. Hillebrand had a lively correspondence and exchange of plant materials.

The size and importance of the Hillebrand Melbourne collection was not known. Therefore, I spent two weeks (22 July - 5 August, 1981) inventorying and photographing the collection before attending the 13th International Botanical Congress in Sydney. Dr. Churchill was most accommodating in obtaining personnel and needed equipment for this task. Most of the specimens were still filed unmounted in the Polynesian collection as left by von Mueller in 1896. The search was undertaken mainly using scientific names from Hillebrand (1888). Additional search time was spent on Hawaiian genera that had proposed threatened,

endangered, or extinct taxa. From a record book showing plant genera von Mueller received, I cross-referenced the genera received with those found. A search for outstanding genera is presently underway. (This search may yield $\pm$ 30 specimens to be photographed and sent to me.)

All specimens located by August 1, 1981 were mounted and photographed using black and white 35mm Kodak Plus X film, a Pentax camera, and tripod. Two sets of 8 x 10 inch glossy prints are being developed from the film negatives - one set to go to B.P. Bishop Museum and the other to the Hawaii Division of Forestry and Wildlife.

Hillebrand's specimens are insect-free and in excellent condition. Of 559 sheets photographed, 385 are flowering plants (angiosperms) and 184 are ferns or fern allies. Three hundred and fifty-eight angiosperm sheets are separate taxa; however, more duplicates are present in the fern collection. Of the photographed flowering plants, there are approximately 103 isotypes. Of these, 59 are considered for endangered, 15 for threatened, and 27 for extinct status (Ayensu and DeFillips, 1978). The scientific names on the herbarium sheets have been cross-indexed with the name Hillebrand used in his book and the currently accepted name. Dr. Harold St. John has graciously provided current names for the angiosperm photographs and Dr. Charles Lamoureux is providing current names for the fern photographs. These names will be entered into the Wang computer for printout.

The goals of the inventory are to: (1) establish what Hillebrand specimens are available for loan at Melbourne, (2) publish the plant listing for other people's use, and (3) use the photographs wherever possible to reduce wear and tear of these irreplaceable specimens. Some may be the only collection made of a plant now considered extinct.

People desiring a printout of Hillebrand specimens found at Melbourne and/or wanting particular prints should contact me at the Hawaii Division of Forestry and Wildlife, telephone no. (308) 548-2861.

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SOCIETY BUSINESS

Senator Ben Cayetano, Chairman
Economic Development Committee
State Capitol, Honolulu HI

RE: Testimony on SB 903

Dear Senator Cayetano:

The Hawaiian Botanical Society wishes to make known to you and your committee its views regarding Senate Bill 903. We consider the proposal to include the production of geothermal energy as a permitted activity within conservation zones to be contrary to the purpose and function of those zones. Originally designated as forest and water reserves and renamed as conservation districts, presumably to imply protection of resources beyond the scope of the initial concerns, these areas were definitely not set apart from commercial, residential, and agricultural lands with the intent of permitting commercial/industrial use. Conservation districts, together with designated natural areas, wildlife refuges, and other areas with legislated protection, are the only places where we can be reasonably assured of defense against the encroachment of such use on the environment.

We are concerned with respect to the trends in degradation of natural habitats in the Islands and the consequences to species dependent upon these habitats for survival. As you know, Hawaii has a long list of species considered endangered or threatened and a lamentable history of many more already lost, nearly all as a result of the influence of humans in their environment. The regions in question contain populations which may well not survive without the continued protection afforded by conservation districts, and by the preservation of the integrity of the conservation district concept. It seems self-evident that the situation cannot be held to present standards, much less remedied, if we condone developments of the type proposed in the very locations that most need protection.

While the Hawaiian Botanical Society was not organized to act as a political advocacy group, on this issue that necessarily involves the welfare of our primary interest - Hawaiian plant life - we have resolved to offer our opinion.

We would prefer that the concept of conservation districts be maintained and that those districts be truly reserved from any industrial activities, including the ones specifically addressed in this bill.

Sincerely,
S.H. Sohmer, President
Hawaiian Botanical Society

HAWAIIAN PLANT RESOURCES FOR TAPA: THE RECORD IS FAULTY

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Though Broussonetia papyrifera (L.) Vent. furnished the bulk of the raw material for Hawaiian as well as most Polynesian tapa or barkcloth, and was called wauke in Hawai'i, several Hawaiian endemic species are said to have been used for tapa also. Among them, Brigham (1911) and Kooijman (1972) cite the Hawaiian raspberries ('akala), Rubus hawaiiensis Gray and R. macraei Gray. Last year, through the kindness of C.W. Smith and this year through the kindness of Evangeline Funk, both of the Hawaiian raspberries, which were collected on Haleakala, Maui, were subjected to tapa preparation. They were stripped of outer bark, soaked for 3-4 days in daily changes of fresh water, and finally pounded with a wooden tapa beater. The dark fibers are relatively short and randomly arranged, and do not form any sort of felted fabric. They look very much like treated hau (Hibiscus tiliaceus L.) fibers which also are said to have been used for tapa (Brigham, 1911, pp. 134-135 and Degener, 1930, p. 215, citing Brigham). In all three species, the plant fibers do not felt into fabric. I believe that the reports that cite these species as the raw material for tapa are in error, possibly from misunderstanding the Hawaiian informants, or from misinformation. Funk (1979) has shown that common Hawaiian names for many of the fiber plants were recorded without question, resulting in the same vernacular name being applied to a number of different species, or several vernacular names used for one species. Both of these practices are thought to be mistakes by students of Hawaiian folk taxonomy, for the record is replete (Handy, 1940; Handy & Handy, 1972) with examples of nearly individual plant-specific names for many Hawaiian plants of which taro and sweet potatoes are but two examples.

Buck (1957, p. 158) offers a puzzling statement on 'akala: "According to Brigham, the bark (of 'akala) was used for tapa which was not so good as that from wauke, mamaki, and oloa (Brigham, 1911, p. 135). However, this is not probable". It is not clear that he thought 'akala was not used, or was poorer than those of the other species. He later (Buck, 1957, p. 169) mentioned that Malo (1951) did not list 'akala as a tapa source.

The fibers of most tapa in the Bishop Museum collections that are not clearly of Broussonetia or Pipturus have been examined microscopically and none match those of 'akala or hau. Finally, many plants with better fibers for tapa than 'akala and hau were not used (or we haven't found the finished pieces yet). Such are the endemic Boehmeria ('opuhe; see Funk, 1979), and fibers from a plant that the Polynesians brought with them,

Artocarpus altilis (Parkinson ex Z.) Fosberg, the breadfruit or `ulu, which other islanders such as the Marquesanas (Handy, 1923) used for tapa. Experimental tapa made in my laboratory of `ulu is not as smooth as wauke nor does it have the firm body of this favored barkcloth, but the fibers are white and silky and in expert hands may make a fine piece of fabric. Brigham (1911) stated that `ulu was not used for Hawaiian tapa, but Buck (1957), citing Malo (1951) claims that Hawaiians used breadfruit. It is likely that they did use `ulu for tapa as the trees were frequently planted around dwellings as well as in the lower forests. The finished pieces would be superior to anything made of `akala or `hau. As there are no tapa pieces made of these two species, neither are there any of `ulu in the Hawaiian pieces that I have examined.

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THE KILAUEA WILDERNESS MARATHON AND CRATER RIM RUNS:
SOLE SEARCHING EXPERIENCES

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The problem of noxious weeds being transferred by man from island to island can be controlled in a small way as shown by having the soles of running shoes scrubbed prior to a marathon. Though greeted at first with mixed feelings, between 80-90% of the runners in the First Annual Volcano Wilderness Marathon agreed to have the soles scrubbed. From the scrubblings, 15 species of flowering plants were germinated.

The crowd grew silent as the message was delivered. "Have you had your soles scrubbed today? If not, step this way so you can run with a clean conscience." Slowly, runners came up to the benches to have the soles of their shoes scrubbed for noxious weed seeds.

On Saturday, January 29, 1983, 900 runners participated in the First Annual Volcano Wilderness Marathon and Summit Caldera Rim Run (ten miles) and Kilauea Iki Crater Run (5 miles). The runs were held in Hawaii Volcanoes National Park (HAVO) on the Island of Hawaii (Fig. 1). They were sponsored by HAVO, the Volcano Art Center and the Sheraton Volcano House. The Marathon course traversed Ka'u Desert and parts of Hilina Pali, Chain of Craters, Escape and Crater Rim Roads. The ten- and five-mile courses were established along trails surrounding Kilauea Crater. The terrain and vegetation for these runs varied from `a`a and pahoe-hoe lava flows to scrub lands to `ohi`a forests with a dense understory of tree ferns.

It dawned on several biologists at HAVO that a run of this size might have negative impacts on the Park's trails and fragile native ecosystems. Although no formal procedure is used to screen individual Park hikers for the seeds they might carry on their shoes, it was felt that with such a large number of runners there might be an increased possibility of negative impact of weed introduction into the Park. A large number of the runners registered were from the island of O`ahu where there are many noxious weeds that either are not present on the Island of Hawai`i, or, are now present in low numbers and/or isolated populations.

On the day of the race, a shoe scrubbing station was set up adjacent to the runners' check-in stations. At this station, 15 metal trays and scrub brushes were provided for runners. The scrub station was manned by volunteers who scrubbed shoes from 5:30 am to 9:30 am. Brochures were available that briefly highlighted problems with a few noxious weeds and what can be done to curb their spread. A public announcement system was used periodically to remind runners to have their shoes scrubbed.

The scrubbing of shoes and soles went very smoothly. Many runners asked the reason for doing this. Some thought it was a joke at first, and some believed that it was somehow a gimmick to make you run faster. Knowledgeable volunteers explained the problem and most runners agreed to the procedure. Many were actually shocked that they might be carriers of noxious plants to another island. There were, of course, a few complaints. Of the 900 runners, we estimate that 80-90% of them had their shoes scrubbed. The runners who complained the most and who avoided shoe scrubbing stations were Volcano Village residents (a small community adjacent to HAVO), some Park personnel, and their family members.

At the end of the scrubbing, the metal trays were emptied and sifted into three different categories: large material (grass clippings, leaves, large seeds); medium-sized material (pieces of cinder, rocks); and small-sized material (pieces of small seeds, soil). A dissecting microscope was used to sort out seeds, and five plant species were tentatively identified. Next, the seeds were planted in three trays. A total of 16 species germinated from the collected material (Table 1) and were identified. Of these, 12 are common: Hypochaeris radiata, Bidens pilosa, Melinis minutiflora, Drymaria cordata, Cyperus spp., Mimosa pudica, Crotolaria sp., Ageratum conzioides, Poa annua, Eragrostis pectinacea, and Setaria palmaefolia.

One harmful and destructive plant found was Melinis minutiflora (molassesgrass). This grass is already in the Park and is a problem in certain areas. It forms thick, impenetrable mats and inhibits reproduction of native plant species. Molassesgrass could spread to other areas in the Park such as the scrub vegetation in the Ka'u Desert traversed by runners. Further spread of weeds in the Park means more work for HAVO's resource managers.

We believe that pre-race information about noxious weeds should be sent to runners with their registrations forms. Runners need to be aware of the potential for introducing new weeds from soil on shoes and clothing, to the National Parks and to other islands. Runners should be asked to scrub their shoes before leaving other islands, especially those arriving several days early for pre-race practice. They should be aware that shoes will be scrubbed prior to each run in the Park.

The educational value of this type of "sole cleansing" experience is extremely valuable. Participants in the Kilauea Wilderness Marathon and the Crater Rim Runs ran a race with a new understanding of the impact each one of us has on the native Hawaiian forest and ecosystems. Finishers of these runs will long remember the day of their first "sole scrub" and that their soles could be carriers of noxious weeds that through the decades have contributed to the decline of Hawaii's native ecosystems. These runners can honestly say that they've run through a very unique and special place, Hawaii Volcanoes National Park, with clean soles and they probably will run clean forever.

Table 1. List of Plants Grown from Seeds Collected from Runners' Shoe Soles, Volcano Wilderness Marathon, Summit Caldera Rim Run and Kilauea Iki Crater Run, Hawaii Volcanoes National Park, 29 January 1983

MONOCOTLEDONS

CYPERACEAE
(Sedge Family)

Bulbostylis capillaris (L.) C.B. Clarke
Cyperus sp.
Cyperus sp.
Cyperus sp.

GRAMINAEAE
(Grass Family)

Elusine indica (L.) Gaertn. - goosewiregrass
Eragrostis pectinacea (Michx.) Nees - Carolina lovegrass
Melinis minutiflora Beauv. - molassesgrass
Poa annua L. - annual bluegrass
Sacciolepis indica (L.) Chase - glenwoodgrass
Setaria palmaefolia (Koen.) Stapf. - palmgrass
"Grass"

DICOTLEDONS
CARYOPHYLLACEAE
(Pink Family)

Drymaria cordata (L.) Willd. ex R. & S. - Drymaria

COMPOSITAE
(Sunflower Family)

Ageratum conyzoides L. - Ageratum
Bidens pilosa L. - Spanish needle, beggars' tick

LEGUMINOSAE
(Pea Family)

Crotolaria sp.
Mimosa pudica L. - Sensitive plant

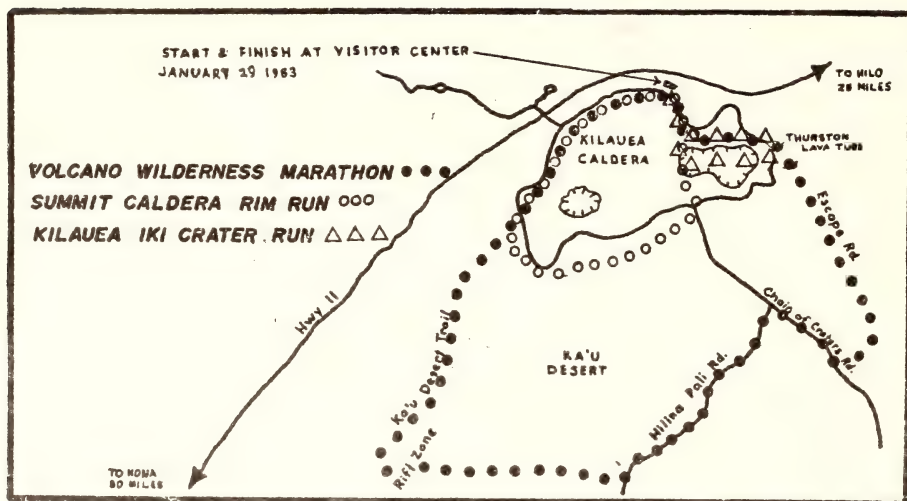


Figure 1. Location of the Wilderness Marathon, Summit Caldera Rim Run, Hawaii Volcanoes National Park. Closed circles - marathon course. Open circles - ten mile run. Triangles - five mile run.

SPRING MEETINGS

January 30, 1984. (Joint meeting with the Hawaiian Audubon Society). Speaker: Dr. Peter Grant, University of Chicago. "Evolution of the land birds of the Galapagos".

(Since there will have been two meetings in January (Jan. 3 and 30), there will be no February meeting.)

genetics, Washington University, St. Louis. "Genetic management of rare and endangered species: lessons learned from Hawaiian Drosophila"

April 2, 1984. Speaker: Dr. Douglas Futuyma. "Coevolution of plants and insects".

Note: Prof. W. H. Wagner, Jr., University of Michigan, will be here in mid-April. Since he is coming at a time that the Society does not meet, please look elsewhere for an announcement of his speech. Dr. Wagner is a fern specialist. 639

ENVIRONMENTAL IMPACT STATEMENT ANALYSIS
AND THE ROLE OF THE ENVIRONMENTAL CENTER

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Background

A discussion of the role of the Environmental Center in the analysis of Environmental Impact Statements (EIS's) must begin with some explanation of the origin and functions of the Environmental Center.

The Environmental "movement" began in the late 1960's, and the concerns expressed during those formative years, at the Federal level, culminated with the passage of the National Environmental Policy Act (NEPA) in 1969. Concomitantly, the State of Hawaii was also moving ahead on the development of appropriate legislation to meet the environmental needs of the State. In 1970, the State Legislature passed the Environmental Quality Control Act which later became Chapter 341, of the Hawaii Revised Statutes (HRS). HRS 341 established three environmental organizations in the State: the Office of Environmental Quality Control (OEQC) in the office of the Governor, the Environmental Center of the University of Hawaii, and the Environmental Council, a 15 member body appointed from the private sector, to serve as a liaison between OEQC and the general public. By Executive Order in August 1971, OEQC was given specific responsibilities with regard to the receipt, review, and dissemination of EIS's and their coordination with other state agencies and the Environmental Council. In 1974, the EIS system was expanded and further defined with the passage of the Environmental Quality Commission and Environmental Impact Statement Act 246. Act 246, (HRS 343) established the Environmental Quality Commission (EQC) whose primary responsibility was to develop the rules and regulations under which the more specifically defined EIS system would operate. The operations of the present State EIS system are based on compliance with these regulations.

Just as the main function of the OEQC was to coordinate environmental planning, review, and evaluation among the various State agencies and with the public through the Environmental Council, so the Environmental Center was to coordinate environmental review and evaluation within the University of Hawaii. In this coordination role, three specific areas of responsibility were delegated to the Environmental Center by the enabling legislation, HRS 341. Specifically, the EC was mandated to "stimulate, expand, and coordinate education, research and service efforts of the University related to ecological relationships, natural resources, and environmental quality" with

special emphasis on humans need, social institutions, and the State.

The education responsibilities of the Center are covered by the Environmental Studies program. Research responsibilities include the identification of environmental research needs in the State, the personnel with expertise to address those needs, and the sources of funds to conduct the identified research. The Service efforts of the Center include the co-ordination of reviews of environmental documents prepared for or related to the State of Hawaii, and environmentally related legislation. We also serve as a general source for information on environmentally related questions raised by both governmental agencies and the public.

The review of Environmental Impact Statements is but one type of review, albeit a significant type, conducted by the Center. For this presentation, I will focus on the role of the Environmental Center in the review of Environmental Impact Statements.

Environmental Impact Statement Review

Procedure

The Environmental Center routinely receives copies of all EIS's prepared for the State of Hawaii including those pertinent to Hawaii that are prepared under Federal regulations (NEPA). We also receive for review a number of other types of environmental documents including, Corps of Engineers permits, Conservation District Use Applications, Department of Health National Pollution Discharge Elimination System (NPDES) permits, Zone of Mixing permits, and other miscellaneous environmentally related documents. In each case the review procedure is basically the same. A brief in-house review of the material is first conducted to determine the critical areas of concern. We then consult our files and lists of potential reviewers to ascertain who, within the University community, would have the necessary expertise to review the critical areas of concern. A copy of the document is then forwarded to three or four appropriate reviewers for their study and comments. A few days later, the comments are collected and we set about preparing a single coordinated statement, incorporating the comments from each of our reviewers (and acknowledging their assistance in the preparation of our review). When completed the EC review is sent to the proposing agency or applicant, as appropriate, with a copy to the Office of Environmental Quality Control for their information.

Evaluation

It must be emphasized that the Environmental Center's review is a review of the adequacy of the document to describe the existing conditions and the impacts that can potentially occur

should a particular project be undertaken. It is not a review of the merits of the project.

The following questions are typically asked when we begin our review:

1. What kind of a project is being proposed? Is it a new highway project, an expansion of an existing roadway, a hotel or resort complex, a housing development, energy related construction, or any one of a number of other types of projects?
2. Where is the project going to take place? Does it involve undeveloped land, urban areas, wilderness, wetland, pristine mountain or valley areas, the coastal zone, streams, etc.?
3. When is the project scheduled to begin and end?
4. What are the recognized potential impacts?
5. What mitigative measures are proposed to alleviate or reduce the impacts?
6. What cumulative or secondary impacts can be expected to occur?

Discussion

In evaluating these questions, good maps are essential. Location maps, maps showing the physical characteristics of the land involved, i.e. soil types, rainfall, roads, elevations, access, land use, construction schedules, and archeological sites, etc. are some examples of the types of graphic materials facilitating the review. Overlay maps are perhaps best but their cost may be prohibitively expensive for small projects. In any case, interrelationships should be shown on maps whenever possible.

In each case, be it maps or text, the primary concern of the preparer or reviewer of the document should be the relevance of the information presented to the evaluation of the impacts. In reviewing any document it is important to recognize that each project is specific unto itself. That is, the significance of the impacts will be dependent on the specific type of project and the specific location where the action is to take place. One cannot adequately review an EIS by using a pre-designed check-list applicable to all things. Soil loss impacts may be greater if construction is scheduled for the rainy season. Migratory species may be more or less affected during certain seasons. Social disruption will be greater if highway construction will take place during school months or peak traffic periods on a daily basis. Tabular material, such as air or water quality data, species lists, or other measured environmental

parameters must include the rationale as to their importance. Data lists, while desirable for permanent baseline data records, provide little guidance to the non-specialist who must make the decision on the significance of the information presented to the undertaking of that project. Rationale, for example in the case of botanical lists, besides noting the endangered or threatened status of some species, could include species that provide shade, control erosion, provide habitat for native fauna, or are aesthetically of interest.

The sources of the information presented in the EIS is of interest in our EC review. Specific statements made in the document must be appropriately referenced. Sufficient information should be provided to permit the reader to understand the rationale for the use of the cited material. If necessary, the source should be abstracted and/or included in the appendix. Acknowledgement of the authors of the information presented in the document is extremely helpful. This is particularly true in our local community where most of us who work frequently with members of the environmental community are well aware of the talents of specific members of the community.

The comments submitted by earlier reviewers at the preparation or draft stage are of interest in identifying areas of broad concern in which the University expertise may be able to provide some guidance. Similarly, the letters indicate which, if any, of our particular concerns have not previously come up for discussion, and therefore may need special attention.

Conclusion

The value or effectiveness of the Environmental Center's role in the review of Environmental Impact Statements is difficult to measure. In some respects such measurement is similar to the measurement of the value and effectiveness of the EIS system. Projects have been modified as a result of the EIS system and the Environmental Center reviews. Some projects have been withdrawn when their negative impacts appeared significantly to outweigh the advantages of the proposed development. There is no way to measure the number or types of projects for which EIS's were never prepared because the developers realized that the Environmental Impacts that would be identified in the review process would be so adverse that public pressure would preclude approval of the project.

If the number of requests for our services, reviews, task force and committee participation, and general advice on environmental matters is any measure of the perceived value of the Environmental Center's input, then I am pleased to say that we enjoy a responsible and reasonable reputation in the community for objective evaluation of environmental problems.

STAND-LEVEL DIEBACK IN NEW ZEALAND FORESTS
AND THE THEORY OF COHORT SENESENCE

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Introduction

A year ago I gave a talk on a similar subject (Mueller-Dombois 1982b). At that time, my wife and I had just returned from a sabbatical year in the Melanesian islands, where we had collected information on the islands' vegetation, particularly their indigenous forests. So, the question may be asked: What's new? -- Well, certain developments have occurred since then. A number of forest researchers in New Zealand and Australia have been made aware of the native forest dieback in Hawai'i, and the first international symposium on problems of "Forest Dieback and Dynamic Processes in Pacific Forests" took place a few weeks ago (in February 1983) in Dunedin, New Zealand, during the 15th Pacific Science Congress.

When speaking about forest dieback or stand-level dieback, I assume that most of you know about the phenomenon in our native rain forests in Hawai'i. The problem that whole forest stands lost their canopy foliage over large acreages on the windward slopes of Mauna Kea and Mauna Loa, was discussed many times in Honolulu's newspapers in the last decade. Also, at least two or three talks were given about this phenomenon to the Hawaiian Botanical Society.

In my last year's presentation I emphasized that such canopy dieback is not unique to Hawai'i and that it occurs in various other Pacific forests. Dieback is manifested in groups of trees which have lost much of their crown foliage while the trees are still standing. Such dead or dying tree groups may be continuous over many hectares of forest land, or they may be discontinuous and patchy but occurring repeatedly in the same forest area. The basic question that I have been following is this: Is the structural similarity that dead or dying tree stands have in common a reflection also of a certain similarity in function? In other words: when we see whole tree stands losing their canopy foliage permanently, could this phenomenon have a common functional basis? Or is every situation different?

One unifying theory that so far has prevailed in the minds -- at least of most foresters -- is that such stand-level diebacks are the result of diseases. Another, broadly based theory, which is now gaining support in the industrialized regions around the Atlantic, is that stand-level dieback there is the result of air pollution and environmental toxification due to

acid rain, nitrous oxide, and/or heavy metal contamination. Still another broadly based theory, applicable to stands where neither disease nor air pollution can be made responsible is, that forests die because of climatic change, usually involving drought.

With this, I will turn to New Zealand where stand-level dieback is common in many indigenous forests on the North and South Islands. In New Zealand, a common belief has been that indigenous forests die there because of introduced animals. Particularly, the European red deer was made responsible for stand-level dieback in New Zealand's beech (Nothofagus) forests, and the Australian possum for stand-level dieback, particularly in New Zealand's rata-kamahahi (Metrosideros-Weinmannia) forests.

Prior to the symposium in Dunedin in February 1983, certain New Zealand colleagues had arranged field trips for us to their study areas on the North and South Islands. Through their arrangement (and financial support acknowledge below) three of my graduate students (Jim Jacobi, Lani Stemmermann, and Nadarajah Balakrishnan) and I had an opportunity to see and discuss stand-level dieback in several of New Zealand's indigenous forests.

I will first report on three New Zealand forest systems in which stand-level dieback is as obvious to the eye as in the Hawaiian montane rain forests. Then I will briefly discuss the theory of cohort senescence and its relationship to the stand-level diebacks observed.

New Zealand Forest Systems with Stand-Level Dieback as Encountered on Recent Field Trips

Trip to the Kaimai Ranges. -- This field trip was arranged by Dr. T. Allan Green from Waikato University at Hamilton with the help of Graeme Jane (graduate student) and the Chief Ranger of Gordon Ranger Station, New Zealand Forest Service. The Kaimai Ranges are a long, but narrow mountain system near the NE coast and Rotorua on the North Island. They rise to over 900 m altitude and intercept the westerly winds that blow from the SE via Hamilton across the Waikato Plain. Rainfall in the summit area reaches 2000 to 3000 mm per year. Some of the footslope areas are planted with radiata pine and other exotic tree species.

We walked from about 500 m elevation through mostly indigenous vegetation with tawa (Beilschmidia tawa) forests and then along the upper leeward slopes where we came through areas with significant stand-level dieback. In this steep upper-slope terrain there is an alternating pattern of landslides, dieback stands and non-dieback stands. The latter are in various stages of successional development. The main dieback species on the slopes is tawari (Ixerba brexioides: Escalloniaceae), an evergreen broad-leaved tree with long-elliptic and serrate leaves. This species, which is the dominant stand-structure

forming tree in many areas around 700 m elevation, apparently undergoes synchronized crown dieback. Landslides seem to follow as a consequence of such dieback.

Further along the upper slope, the trail entered a larger terrain of gently rolling and nearly level sites in the summit area. Here also, stands dominated by tawari had undergone canopy dieback. However, other tree species such as red beech (Nothofagus fusca), silver beech (N. menziesii), kamahi (Weinmannia racemosa), quintinia (Quintinia acutifolia), toro (Myrsine salicina) and a cedar (Libocedrus bidwillii) grow intermixed with tawari. Many of these also had died, but principally as members of the former canopy stand. Smaller trees of the same species were alive now. It was not clarified whether these survived the canopy dieback or represented new reproduction following the dieback. Perhaps both conditions applied. Two dieback dates, 1914 and 1946, were inferred by Allan Green and Graeme Jane from tree-ring analyses they had made.

Our colleagues suggested that these dates coincided with drought years. The soil in these summit dieback stands, however, were waterlogged. Water was standing at or near the surface in many places. The undergrowth consisted of indigenous shrubs and some reproduction of the same species that had undergone canopy dieback. These boggy summit habitats with so many dead standing snags, but with dense and apparently healthy undergrowth, are clearly reminiscent of the areas in the Metrosideros rain forest on Hawai'i, which we have referred to as being in the state of bog-formation dieback (Mueller-Dombois et al. 1980). Other places in the Hawaiian Islands considered in the same category, are the bog-formation dieback areas on the windward slope of East Maui (the former "Maui Forest Disease" area of Lyon 1909, 1919) and the Metrosideros tree-slag area around the Wahiawa bog on Kaua'i.

Another interesting parallel between the boggy forest dieback areas in the Kaimais and those in the Hawaiian Islands is the occurrence of closed-canopy, even-structured stands of the same tree species composition nearby the dieback stands. Graeme Jane referred to the even-structured, closed-canopy stands in the Kaimais as "disaster-prone stands", implying that their canopy may collapse any time when drought conditions recur.

Trip to Craigieburn Forest Park.--This trip was arranged by Dr. Udo Benecke, who currently directs forest ecological research in the Protection Division of the New Zealand Forest Service. Several of his associates (Ian Payton, Robert Allen and Albert Reif) accompanied us on this trip. Craigieburn Forest Park, which lies about 100 km northwest of Christchurch but on the eastern side of the central mountain range on the South Island, is covered largely with indigenous mountain beech (Nothofagus solandri var. cliffordioides) forest. This forest forms practically a mono-specific system. There is no other tree species but mountain beech in the canopy or undergrowth.

Significant stand-level dieback occurs over many hectares of gently rolling and steeper mountain slopes near Craigieburn Lodge (Headquarters of the Park). Here, the dieback pattern currently has the "salt-and-pepper" physiognomy, similar to Metrosideros dieback areas in Hawai'i. This pattern refers to smaller groups or patches of dead or dying canopy trees that occur repeatedly throughout a matrix of canopy trees with more or less fully foliated crowns. Dr. Benecke explained that this pattern had appeared only within the last 20 years. It had spread rather uniformly over the broad (2 km wide) slope opposite the Lodge moving from the bottom upwards in a matter of a few years. Before that date the mountain sides were clothed by a continuously green and uniform tree canopy. Closer inspection of the dead or dying canopy tree patches revealed that underneath occurred dense reproduction from seedlings of mountain beech. Older dead tree groups were associated usually with taller reproduction than the more recently dead tree groups, which were associated with smaller seedlings.

Another form of "dieback" was also apparent, where larger openings had been created through windfalls, often associated with snow breakage. This was explained as a "domino" effect, whereby non-dieback trees, once exposed through neighboring crown-dying trees, may become more susceptible to wind damage and then are uprooted during storms together with the trees that had already lost much of their foliage prior to this more catastrophic disturbance.

It should be mentioned here that I distinguish between canopy and/or stand-level dieback (which refers to groups of standing trees that have lost much of their foliage permanently) and levelled tree stands (which refers to groups of down or fallen trees). Tree-stand levelling is commonly the result of more obvious catastrophic disturbances. Therefore, in the monospecific mountain beech system of Craigieburn Forest Park, two forms of forest disturbances were found to be coexisting side-by-side, foliage loss among groups of standing trees (= stand-level or canopy dieback of the "salt-and-pepper" variety) and catastrophic stand-levelling through storm and snow breakage resulting in larger openings. These often extend over several tens of hectares in the mountain beech forest system.

Trip through the Beech Gap. -- We then travelled west crossing the Southern Alps via Arthur's Pass (923 m) into the so-called Beech Gap. This area is so called because Nothofagus species are absent. Instead the natural vegetation on the mountain slopes, from near sea level to about 900 m altitude, is dominated by rata-kamahi (Metrosideros umbellata-Weinmannia racemosa) forest. Occasionally tree ferns (Cyathea spp.) are associated. This contributes even more to a certain physiognomic similarity of this southern Metrosideros forest with that of the native Hawaiian rain forest. The Beech Gap is a narrow (30-40 km wide) but 200 km long mountainous land segment along the mid-section of the west coast on New Zealand's South Island.

The total replacement there of beech by the rata-kamahi forest is believed to have historical rather than environmental reasons. Climatically and edaphically at least there appears to be no reason why Nothofagus forests could not grow in the Beech Gap and vice versa, i.e., why Metrosideros forests could not grow in many parts also of the beech forest environment. The Beech Gap is still an unresolved paleo-geological puzzle.

In many areas of the Beech Gap, rata-kamahi stands have died or are in a dieback state. One may think that such stand-level or canopy dieback in this area may signify the evolutionary decline of a relic forest. However, no forest researcher in New Zealand seems to assume such a cause for the widely occurring rata-kamahi stand dieback. Instead, the prevailing explanation has been until recently that the introduced Australian possum (Trichosaurus vulpecula) is the cause. The exotic possum which occurs in great numbers in this forest ecosystem, climbs these native trees and feeds on their foliage. It thereby causes drastic and widespread canopy defoliation. However, a growing number of New Zealand forest researchers believe now that possums are not the sole cause of the canopy defoliation in these forests, but that at least some of the dieback is natural.

Dr. Benecke showed us new research under way at Camp Creek near Otira. Of particular interest to the dieback question was a defoliation experiment done by Dr. Ian Payton. Metrosideros umbellatus sample trees were carefully hand-defoliated and their trunks are equipped with tall sheet-metal collars to prevent possums from climbing up. Periodic remonitoring has revealed so far that leaves re-emerge on defoliated trees in younger or more vigorous life-stages, while older trees and/or branches seem to remain barren.

Regeneration research underway by Robert Allen in a severe rata-kamahi dieback area of the Kokatani Catchment (near Hokitika) has revealed that rata seedlings rarely occur under dieback stands. Instead they occur in the same area, but where landslides have exposed new rocky substrates on the slopes. We were flown by helicopter into the Kokatani Catchment where the stand-level dieback is extremely severe. It was pointed out the possums definitely had contributed greatly to this massive defoliation, but the undergrowth, including sapling trees of the more shade-tolerant Quintinia (Quintinia acutifolia), puka (Griselinia lucida) and abundant tree ferns, appeared vigorous. The situation is similar to the Metrosideros displacement dieback occurring in the tree fern dominated Ola'a Tract of Hawaii Volcanoes National Park (Mueller-Dombois et al. 1980).

Subsequently we visited another study area of Robert Allen in the Fox Glacier Valley. Here, apparently rata-kamahi dieback is associated with rata and kamahi seedlings regenerating directly under the dieback canopies. The substrate consists of more recently exposed rocky glaciated material. It seems that rata seedlings grow here under the opened canopy stands because

there is no dense vegetative competition for them. This situation is similar to the wetland and dryland dieback areas in Hawai'i (Mueller-Dombois et al. 1980), which usually occur on shallow lava rock outcrop soils and where 'ohi'a seedlings regenerate often abundantly under the opened canopy in places where there is less competition by undergrowth species.

What is particularly noteworthy in New Zealand's rata-kamahi dieback areas is the observation that rata seedlings come up in these areas in spite of possum herbivory. Mueller-Dombois (1982b) mentioned the peculiar straight-line tree dieback boundary in the valley that harbors Franz Josef Glacier. Here, a rata-kamahi stand dies currently above the 1790 trimline which marks the stand of Franz Josef Glacier of 197 years ago before it retreated further back into the head of the valley. Below this so-called trimline on the same glaciated slope, the forest of similar composition is mostly green and vigorous. This prompted me to inquire in the Park Headquarters of Westland National Park (which includes Franz Josef Glacier), whether there was a fence along the 1790 trimline that would prevent possums from invading the non-dieback forest below.

As a consequence of this inquiry, I learned about the current controversy regarding the causes of stand-level dieback in New Zealand's Metrosideros forests. The prevailing idea that possum is the sole killer has only recently been disputed in two publications that appeared during the last year (Stewart and Veblen 1982, Veblen and Stewart 1982). These researchers have come to the same conclusion that we have reached with regard to the Metrosideros stand-level dieback in Hawai'i, namely that it is largely a function of life-cycle dependent dying in combination with the peculiar stand dynamics of these forests.

The Theory of Cohort Senescence

This theory to explain stand-level dieback has emerged from the various isolated facts accumulated during our dieback research in Hawai'i (Mueller-Dombois et al. 1980, 1983) and through comparisons with other Pacific forests, particularly in Papua New Guinea (Mueller-Dombois 1982a) and New Zealand (Mueller-Dombois 1982b).

The term cohort as defined in Webster's New Collegiate Dictionary (1977: 218) applies to "a group of individuals having a statistical factor (as age or class membership) in common in a demographic study". Translated to forests, a cohort is an even-structured stand that is composed of structurally and functionally (= physiologically) similar individuals. The term senescence is defined with regard to botanical organisms as "the plant growth phase from full maturity to death that is characterized by an accumulation of metabolic products, increase in respiratory rate and loss of dry weight, particularly in leaves and fruit". Senescence is a life stage, others are infancy, adolescence or maturity. Unlike old age, however,

senescence may be in part reversible or it can follow adolescence under certain severe environmental and physiological constraints.

In the theory of cohort senescence, the events leading to stand-level dieback are seen in form of a chain reaction as follows:

1. A catastrophic disturbance gives rise to a new habitat for plant invasion. Such catastrophic disturbances can be new lava flows, ash-blanket deposits, land slides, fire or other stand-levelling disturbances, such as severe storms (hurricanes). A sudden recession of a glacier or the sudden release from overgrazing would also fall into this category as historical events that provide for newly exposed habitats.
2. Plant invasion usually follows when a new open habitat is created. The rate of invasion depends on rainfall, temperature, the soil substrate and also on the seed sources available. Among the seed sources there must be a tree species that is capable to invade such newly opened habitats with an abundance of seeds or propagules. Metrosideros polymorpha in Hawai'i, Ixerba brexioides in the Kaimais, Nothofagus solandri var. cliffordioides in Craigieburn Park and Metrosideros umbellatus in the Beech Gap seem to fulfill this requirement.
3. The cohort individuals that got established from such a regeneration wave (which can also be artificially created through a plantation stand) then grow through their different life stages and eventually reach their senescing phase. A cohort stand can reach this senescing life stage only in habitats which remain free of catastrophic perturbations (such as cutting, fire, hurricanes or other stand-levelling disturbances) throughout the life cycle of the cohort stand.
4. However, at the onset or during the senescing life stage a trigger factor may become effective which then further synchronizes and aggravates the tree-group dieback. Such a trigger may be a temporary soil drought or root flooding, which would not have caused dieback in the same stand when it was in an earlier more vigorous growing stage. A normal storm, blowing with gusts up to 50 miles per hour may cause substantial loss of crown foliage in such a senescing stand. The lost leaves may then not be replaced because of the low vigor of this stand.

It is currently believed that the above factors are triggers in the Hawaiian native forest dieback. Volcanic SO₂ fuming also may act as a trigger for stand-level dieback in the senescing phase of Metrosideros stands in the Hawaiian Islands. Similarly, in New Zealand's Metrosideros forests, the Australian possum may act as a trigger rather than as an

outright killer. This would explain in part why the possum does not feed on the rata seedlings or younger more vigorous trees. Certain metabolic products, such as indigestion-causing phenolics, may leach out of the leaves of low-vigor trees, which make these trees attractive to leaf eaters.

5. Subsequent to the dieback trigger, a dieback hastening factor may develop. This role seems to be fulfilled in Hawai'i in some stands by the endemic Metrosideros borer (Plagithmysus bilineatus) or by the root pathogen Phytophthora cinnamomi in certain other dieback stands on permanently moist soils (Papp et al. 1979). However, where a trigger may only create a temporary stress, such as temporary flooding followed soon by a restoration of better drained conditions, senescing stands may temporarily recover.

Conclusions

The cohort senescence theory implies a chain-reaction of causes which involves a newly opened habitat, establishment of a cohort, then after stand development a senescing or low-vigor life stage during which canopy collapse is triggered by another disturbance. This second disturbance is of a different nature than the one that opened the habitat for the initial invasion of the cohort. The second disturbance is of a different nature than the one that opened the habitat for the initial invasion of the cohort. The second disturbance does not kill vigorous stands which may grow right next to a dieback stand. Such vigorous or non-dieback stands are found in all forest ecosystems here considered.

Wherever canopy dieback occurs, increased light conditions affect the undergrowth vegetation. This in some habitats stimulates a new regeneration wave of the dieback species (replacement dieback) or it may stimulate other species in the undergrowth to become more vigorous, thereby outcompeting the dieback species (successional displacement dieback). All these conditions are found in the Hawaiian dieback.

In New Zealand, an additional variation is the greater frequency of stand levelling, i.e., catastrophic disturbances, which occur in the three forest systems visited. Ixerba dieback on the slopes in the Kaimai Ranges is often followed by landslides. The same applies to Metrosideros-Weinmannia dieback on the steeper slopes in the Beech Gap. Stand-levelling is also common in the Nothofagus forest at Craigieburn, but there it is due to snow breakage and storms. In these cases, senescing cohorts seem to create conditions for stand-levelling. The stand-levelling events then follow sooner or later through more catastrophic disturbances. The later in turn create the conditions for large cohorts to reinvade. Thus, the New Zealand forest systems here discussed appear to be characterized by more

frequent catastrophic-dynamic cycles than are found to occur in the Hawaiian Islands.

Acknowledgements

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In addition, I wish to express sincere thanks, also on behalf of my above-named research associates, for the great hospitality received from our New Zealand colleagues, especially Drs. T. Allen Green and Udo Benecke. The field excursions organized by these colleagues and attended by their associates Graeme Jane, Robert Allen, Dr. Ian Payton and Dr. Albert Reif, gave new and valuable insights into problems common to indigenous forests in New Zealand and Hawai'i. Travel support in New Zealand was provided by the University of Waikato and the New Zealand Forest Service.

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The Nature Conservancy News

The November/December 1983 issue of The Nature Conservancy News has just been released. It is subtitled "What's a species worth?" This publication is brought to your attention because it will be of particular interest to most of our members. No, it is not devoted to Hawaiian problems. In fact, Hawaii is only mentioned in passing in an illustration. The value of this publication is its very readable presentation supporting the preservation of all species.

The journal begins with an introduction by Edward O. Wilson in which he discusses the preservation of diversity from several different viewpoints. It is followed by Norman Myers' "By Saving Wild Species, we may be Saving Ourselves" which enumerates several benefits derived from wild plants. In agriculture, he reiterates a familiar theme of his that the continuous inbreeding of the fifteen or so plants on which we are most dependent is leading us toward disaster. The medicinal benefits derived and still being discovered in plants and animals are extraordinary and far-reaching. However, it is in the industrial uses of plants and that he makes his most poignant point. As we squander our petrochemicals we will have to resort to phytochemicals. But it is the many and diverse uses of biological products in industrial applications that makes one realize how dependent we are on the diversity of life. Daniel Simberloff then succinctly explains some modern concepts of biogeography and the importance of preserves of various shapes and sizes in his article "What a Species Needs to Survive". Thomas Eisner concludes these short essays with a paper on "Chemicals, Genes and the Loss of Species". Here again the great benefits that mankind has obtained from organisms is explained but we have only just begun to survey the potential of living organisms for new chemicals. In fact, most of these chemicals are new to science though most of them are readily synthesised once we know what to produce. There is also a short statement "The (Nature) Conservancy's Endangered Species Program" by J. Paul Eckhardt, describing part of their program.

The value of this 32 page publication is its brief, concise but readable presentation of a much larger literature on the the subject.

HAWAIIAN BOTANICAL SOCIETY
Report of the Treasurer
December 1, 1981 - November 30, 1982

Receipts:

Dues and gifts	\$ 843.00	
Interest	1,135.56	
		\$1,978.56

Expenditures:

Postage	89.55	
Refreshments	89.55	
Donations	99.14	
Lawyer's fees	250.00	
Science Fair trophy	2,086.41	
Telephone	98.80	
Office supplies	1.27	
	55.22	
		2,680.39

Cash flow:

(701.83)

Net worth of the Society:

December 1, 1981		\$17,534.59
Change: December 1, 1981 - November 30, 1982		(701.83)
November 30, 1982		16,832.76

Bank balances:

First Hawaiian Bank - checking account:

Balance December 1, 1981	\$ 1,787.57	
Deposits	2,943.00	
Withdrawals	(2,680.39)	
Balance November 30, 1982	2,050.18	\$ 262.61

First Federal Savings and Loan - Acct. #102586:

Balance December 1, 1981	201.74	
Interest	11.40	
Balance November 30, 1982	213.14	
		11.40

First Federal Savings and Loan - Acct. #111764:

Balance December 1, 1981	2,469.93	
Interest	70.63	
Withdrawals	(2,100.00)	
Balance November 30, 1982	440.56	(2,029.37)

First Federal Savings and Loan - Acct. #C-718689:

Balance December 1, 1981	13,075.35	
Interest	1,053.53	
Balance November 30, 1982	14,128.88	1,053.53

Change in bank balances:

(701.83)

Respectfully submitted,
Derral Herbst, Treasurer

NEWSLETTER,
HAWAIIAN BOTANICAL SOCIETY,
C/O DEPARTMENT OF BOTANY,
UNIVERSITY OF HAWAII,
HONOLULU, HAWAII 96822



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Newsletter

Hawaiian Botanical Society



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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

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LEHUA MAKU NOE -- AN ENDANGERED HAWAIIAN BOG

(Some notes and impressions)

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Although famed in song, myth and history, little is known about the origin and ecology of Lehua Maka Noe, the most easily accessible of the ancient bogs of the Alakai Plateau, Kaua'i. Selling (1948) however, has provided a sketch, sections and a photograph as part of his monumental report on the montane bogs of Hawai'i. His field work was done in 1938 during the Hawaiian Bog Survey, led by the late C. F. Skottsberg. As a member of this group I made a brief study of the plant cover and took some peat samples along two transects. Now that the tiny bog appears threatened by the proposal to build an earthen dam 190 feet and 1000 feet wide across the headwaters of Kawaikoi Stream, to the south of it (and not far above Tsugi Grove Camp), I realize that my old notes begin to take on historical value and may stimulate intensive study and further questioning of the Pua Lua-Koke'e Hydropower Project before it is too late.

This is of course an area rich in endemic species, the bogs themselves offering a blending of subantarctic and specialized Hawaiian species, as Skottsberg stressed in 1939. All components--swamp forest, true bog, and important communities at lower altitudes--would suffer should so much disturbance from construction and roading. Should so much destruction of forest and subsoil be allowed in favour of hydropower, canefield irrigation, and fish-farming?

The urgent fears and doubts of the Society have been succinctly put by Vice President Joan Canfield (1982) in response to the Environmental Impact Statement Preparation Notice received from Mr. Susumo Ono, Chairman of the Board of Land and Natural Resources, Honolulu. While agreeing with the Board that the upland grey clays would provide an excellent sealant for such a dam, I am totally dismayed to learn that the main borrow area envisaged will come close (within about 90 feet) of Lehua-maka-noe, leaving a zone, perhaps 2000 feet wide on its westernmost and northern limits, completely stripped of trees, humus and underlying clay. This will result in an unhealable eyesore, but, worst of all, it will inevitably hasten drainage, robbing the bog of the water needed to sustain it. We do not know all details of the proposal, but we do know that theft of the clay is essential to the successful maintenance of the dam. To rob the clay would be like killing an elephant to profit from its tusks.

The bog: Lehua Maka Noe is an outlier of the extensive bog and swamp complex of the domed plateau. It lies near Koke'e at about 3870 feet above sea-level, and is very close to Wainiha Pali. It slopes gradually, mainly from northeast to southwest, with its top end backing into the northeast trade winds that bring it constant, life-giving mist and rain. It is roughly fiddle-shaped, measuring about 230 yards long and only about 40 yards wide, at its narrowest. The old Koke'e-Alaka'i Trail runs through its length, taking advantage of the open, mainly firm, roughly swardlike surface. Old Hawaiians gathered here to bake in clay jackets the young of sea birds caught on the nearby Kilohana cliffs; thieves of the birds from the same area were sometimes caught with their loads in man-traps dug into the bog. Queen Emma, curious to see the area, was carried across it on a litter, a corduroy surface having been laid down in her honor. The wide impression of the trail was still visible in 1938. Clearly Lehua-Maka-Noe was loved, in contrast to the fear of the Alaka'i swamps, where travellers could be fatally engulfed, or attacked by criminals and packs of wild dogs.

Over the millenia a tug-of-war, depending on small changes in climate and water-logging, must have taken place between swamp forest and bog growth, the clay layer representing part of a podsol developed with intense leaching of iron and alumina under an earlier forest. There is no iron pan here, but the clays are variously iron-stained and nodules are frequent around seven to nine inches below the peats. Foote et al. (1972) gave an aerial view of the bog that suggests a change in outline by 1966. This is probably due to death of many of the dominant trees (*'ohi'a-lehua* -- *Metrosideros polymorpha*) in the fringing tension zone. Many dead and dying trees were also seen here in 1938. This may have been due to water-logging, drought (as claimed for an older forest cover on the Kohala Range), or insect attack. Widespread charcoal in the peat, or just above the clay, point to tree growth, and suggest that the shallowness of the peat, as compared with domed parts of Kilohana Bog, not far away, must be due to natural or man-made fires in drier periods.

The bog margins are rather rich in forest species, with some admixture of bog types - especially the monocotyledons. Young *Cibotium* and some *Coprosma*, *Dianella*, *Dubautia*, *Gahnia*, *Dicranopteris linearis*, *Smilax*, and *Vaccinium* (2 spp.) reached out onto the bog only where favoured by low erect or widely sprawling *'ohi'a-lehua*. The largest "island" of this type was in the middle of the bog. It measured about 42 x 20 yards and contained remains of a six foot tall *'ohi'a*. This species drops from over 20 feet in height in the forest to a small shrub, erect or prostrate, scattered over the bog surface. It is a dwarfed mini-shrub for the main part, its blood-red pompoms of stamens-- which have given the bog its name -- "misty-eyed ohia" -- showing up brilliantly in the low mosaic of true bog species. Briefly, the ecosystem may be dominated by this species with or without *Oreobolus*, or by *Rhynchospora* and *Panicum*, these three tufted monocotyledons being typical of bog communities at higher

altitudes in the islands. On this bog Rhynchospora is physiognomically most important as it contributes most to the swardlike aspect of the vegetation. Oreobolus, a sturdy peat-former throughout its geographical range, is here atypical in that it does not form cushions: it occurs as small tufts or low patches, except for one small area of dominance at the northwest corner of the bog, where more vigorous growth was noted in 1938. To me this suggests potential for the future, and a hint that it could once, before fires and trampling, have been far more important here, and even have formed domed areas (hillocks) as on Pepe`opae Bog (Molokai) and on Kilohana. Such domed growth, above the ordinary water-table, depends on cloud-fed (ombrogenous) conditions -- a poor source of nutrients. At present Lehua-Maka-Noe receives some drainage from its margins, but this does not seem to represent much enrichment as tree growth is seen to be so stunted. Because of its mixed sources of nutrients this bog is termed soligenous, and is really a blanket bog, capable of extending its boundaries in all directions.

The Metrosideros and Rhynchospora-Panicum communities were seen to cover 50 percent or more of quadrat areas where one or the other dominated. Panicum rarely covered more than six percent of these areas, Oreobolus over 50 percent in one quadrat only. In very low frequencies in the various quadrats were Coprosma, Deschampsia, Drosera, Gahnia, Dicranopteris, Ilex, Galeatella (lobelia), Lycopodium cernuum, Smilax and Vaccinium. Mosses tended to form the ground-cover, but no Rhacomitrium, common on many Hawaiian bogs, was seen. Many of the Alaka`i species were lacking in 1938, perhaps due to lower altitude and grazing (in some cases) by cattle, etc. Notable absences were: Astelia, Carex, Machaerina, Lagenophora, Plantago, Selaginella, Polypodium, Sanicula, Schizaea, Styphelia and Viola (though a scandent form was seen on the bog margin). I may, of course, have failed to spot the small Schizaea. Sphagnum palustre, as elsewhere in the islands, forms no peat. It was seen only south of the bog.

Pollen and spores of a wide range of species may be preserved in the peats, but they are so shallow (apparently not deeper than eight inches) as to give little scope for study. In them the main peat-formers are easily traced by only partly humified strands -- reddish for Oreobolus and yellowish for Rhynchospora, both showing up clearly against the greyish-brown ground-mass of grass and other fibres. Radiocarbon dating of lower, undisturbed layers of peat and of fibres in the wet, plastic clay, could still give a clear idea of when bog formation began -- probably, as on Moloka`i, at least 10,000 years ago.

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It's a First for Waimea Falls Park and the World

It's a greyish-colored bush about five feet tall and nine feet wide with branches resembling octopus tentacles laden with large thorns. On the tips of these branches are clusters of blood-red flowers which, according to Keith Wooliams, director of the Waimea Arboretum and Botanical Garden, are much deeper in color than the other species of Erythrinae which have flowered in Waimea Falls Park. This tree is an Erythrina elenae and it is the first time it has flowered anywhere in the world outside of Cuba.

Until recently, no one outside of Cuba had ever seen the flower of this rare tree since it grows wild in just two locations, both in Cuba. But thanks to the persistence of Wooliams, the flower of the Erythrina elenae has now been seen and properly described.

Wooliams had tried for several years to acquire seeds of the tree for research purposes at the Arboretum but was unsuccessful because so much red tape was involved. He finally wrote a letter to Fidel Castro with his request and 15 months later, he received a package containing the seeds.

Wooliams sent some of the seeds to other aboreta and botanical gardens as a gesture of goodwill and planted the remaining seeds at Waimea Falls Park. Now, four years later, Wooliams can see the fruit of his endeavors.

when asked about this botanical accomplishment, Wooliams said, "We're proud, not just of being the first establishment to boast a flowering Erythrina elenae, but also to be able to share this newfound knowledge with the rest of the world. I'm sure many people outside of the botanical society do not realize the importance of having been able to properly describe the flower of Erythrina elenae -- it's been like solving a mystery. But what I think is important is that people realize that good things can be accomplished when leaders separate politics from science."

The Apparent Yellowing Disease of *Dodonaea*: Symptomatology and Considerations of the Etiology

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Introduction

A pathological condition of unknown origin affecting *Dodonaea eriocarpa* Sm. (considered *D. viscosa* by C. H. Lamoureux, personal communication) ('a'ali'i) has been under observation in Hawaii Volcanoes National Park (HVNP) since 1977. *Dodonaea eriocarpa* is indigenous to Hawaii and is an important component of the Park's native flora. The health of *Dodonaea* in Hawaii is of added importance because the fruits and leaves are favored for making "haku" leis. Gardner's (1980) brief report at the Third Conference in Natural Sciences at HVNP was apparently the first documentation of this disease, which has been considered especially significant in light of studies elsewhere reporting that the devastating "spike" disease of sandalwood in India may also attack *D. viscosa* in that country (Hull et al. 1970; Sastri and Narayana 1931; Venkata Rao 1935). To our knowledge, the spike disease remains the only significant pathological condition reported in the literature to affect *Dodonaea* spp. aside from the disease discussed here.

The symptomatology suggests that this condition may be a "yellows"-type disease (see Anon. 1978; Ploaie and Maramorosch 1969; Maramorosch et al. 1968), as sandalwood spike disease has been shown to be (Dijkstra and Ie 1975; Hull et al. 1969; Varma et al. 1969). Although diseases of this category have formerly been classified as virus diseases (Bowyer et al. 1969; Nayar 1967; Sastri and Narayana 1931; Venkata Rao 1935) since no associated bacteria, fungi, or other pathogenic organisms could be observed by light microscopy (Anon. 1978; Maramorosch et al. 1968), in recent years electron microscope investigations have revealed mycoplasma-like organisms (MLO's) in diseased tissue (Maramorosch et al. 1968; Varma et al. 1969; Hull et al. 1969). These organisms, although submicroscopic, have many of the properties of bacteria (Anon. 1978), including sensitivity to certain antibiotics (Hull et al. 1970). Heat sensitivity of MLO's has likewise been used as a diagnostic characteristic and in corrective procedures for yellows diseases. Mycoplasma-like organisms are typically transmitted by leafhoppers (Anon. 1978; Maramorosch et al. 1968; Ploaie and Maramorosch 1969), whereas aphid vectors are more often associated with insect-transmitted viruses.

As an alternative explanation for the observed symptoms, we investigated the association of mites with diseased plant tissue.

Toxins injected during feeding activities of certain eriophyid mites are known to cause physiological abnormalities resulting in growth aberrations in other plant species (see Carter 1962; Jeppson et al. 1975).

Most of our observations of this disease were made in the Mauna Loa strip and the Hilina Pali areas of HVNP, where the condition has become so prominent that it would seem difficult for even a casual observer to overlook. Our observations in other areas where Dodonaea occurs on the islands of Hawaii and Maui indicate that the disease is generally distributed and possibly occurs wherever Dodonaea is found in Hawaii.

As was earlier noted (Gardner 1980), symptoms may occur at any position on a plant and may be restricted to a single branch or involve the entire shrub or tree. The majority of affected plants have a number of branches showing symptoms interspersed with normal-appearing growth. Plants of any size or age may be affected, and symptoms on plants as small as 0.3 m tall or on large tree forms of the host have been observed. Symptoms include yellowing and dwarfing of leaves of affected branches accompanied by a proliferation of fine twigs, which form a dense pendulous cluster, resulting in a "witches' broom". In advanced stages of development, this conspicuous bright yellow growth abnormality contrasts sharply with surrounding normal green foliage. Flowering and fruiting on moderately to heavily affected plants have not been observed and may be inhibited by the disease.

Our continuing observations confirm the pathological, as well as the abnormal and progressive nature of this condition. Although the disease progresses slowly, affected branches and twigs comprising witches' brooms gradually die and become defoliated. Entire plants showing symptoms have been observed to die following gradual decline over several years. We have not noticed any tendency toward recovery of either isolated diseased branches or of entire affected plants.

Materials and Methods

We have attempted to diagnose the apparent yellows disease of Dodonaea through several approaches. Although we recognize that potted diseased and healthy plants maintained under controlled greenhouse conditions could more readily be subjected to various treatments and be otherwise manipulated to conform to experimental requirements, we encountered considerable difficulty locating sufficient numbers of small transplantable diseased plants in the field and transplanting them successfully. We have not discovered how the disease is transmitted; consequently, most tests were carried out in situ.

Fertilization treatment-- To determine the degree to which the yellowing was due to nutrient deficiency, and whether this

symptom could be alleviated by fertilizer application, we conducted a pilot study in which three small (0.6-1.0 m tall) moderately diseased trees were selected. The standard formulation of a commercial water-soluble fertilizer was applied at the recommended concentration to the soil above the root zone on a biweekly basis at first, alternating with only watering. This schedule was later increased to weekly application of twice the normal concentration of fertilizer. Fertilizer application continued for 5 months.

We also injected fertilizer solutions into stems of other diseased plants with modified 50 ml syringes inserted into holes drilled into the xylem tissue.

Heat treatment-- To ascertain possible heat sensitivity of the disease agent (see Anon. 1978; Valenta 1959; Kunkel 1941), a small (0.3 m tall) diseased plant in the field was covered with a plastic tent-like enclosure. An electric space heater, powered by a gasoline generator, was used to maintain temperatures of 46-52 °C (about 115-125°F) for 4 1/2 hours. We fertilized the plant as described above on a regular basis following heat treatment to encourage development of new, healthy growth, which is usually considered conclusive evidence of symptom remission of yellows diseases.. Color photographs were taken of the plant prior to and at intervals following heat exposure to document any treatment effects.

In conjunction with the above field test, healthy potted Dodonaea plants grown from seed in the greenhouse were heat-treated in a laboratory oven for 5 hours at approximately 38, 43, 53, or 58°C. A small diseased tree from the field which had been successfully transplanted to a pot was then heat-treated in the oven at approximately 50°C for 5 hours.

We also conducted a series of hot water treatments. Branches of healthy plants were immersed in water heated in the field to specific temperatures for various time intervals to determine the sensitivity of Dodonaea itself to heat. Based on these observations, 52 typically diseased twigs which could easily be immersed in water were selected, tagged, and photographed in color prior to treatment. Diseased twigs were immersed in water at 39-45°C at intervals from 45 seconds to 15 minutes. Control diseased twigs were immersed in warm water (26 °C) for 45 seconds. Treated twigs were observed and photographed on a regular basis to detect any indication of symptom remission.

Antibiotic treatment-- Since known MLO-caused diseases have been both diagnosed and successfully treated with antibiotics of the tetracycline group (Anon. 1978; Bar-Joseph et al. 1975; Hull et al. 1970; Ishie et al. 1967; Kirkpatrick et al. 1975; McCoy et al. 1976; Raychaudhuri et al. 1972; Varma et al. 1969), aqueous solutions of generic tetracycline HCl and Terramycin Tree Injection Formula, an oxytetracycline HCl formulation used elsewhere for treatment of yellows diseases, were injected into

diseased and healthy control plant stems. Some antibiotic-injected plants were also injected with fertilizer solutions as described above to stimulate production of new healthy growth in the event of symptom remission. As alternate treatment methods, we also drilled holes into lower stems and filled them with a water-Terramycin paste mixture. The holes were then sealed with Parafilm. Following the methods of Raychaudhuri et al. (1972) and Hull et al. (1969), portions of the lower stem bark of diseased and healthy control trees were removed and Terramycin paste was placed in the opening. The wound was covered with Parafilm and tied firmly to prevent drying.

For foliar spray treatments, we selected trees of comparable size showing mild, moderate, and severe disease symptoms, as well as a normal control. The foliage of each tree was sprayed with Terramycin solution to the point of runoff. Spray was applied on a biweekly basis (usually) for 5 months first at 100 parts per million (ppm) concentration and later at 200 ppm.

Insect vectors-- Since MLO-caused diseases are known to be transmitted by leafhoppers (Anon. 1978; Maramorosch et al. 1968; Ploaie and Maramorosch 1969), insect populations associated with Dodonaea in the Hilina Pali and Mauna Loa strip areas of HVNP were assessed at rather widely spaced intervals during the year. Sampling was accomplished by beating foliage of both diseased and healthy plants into insect nets. Numbers and species of leafhoppers which could serve as MLO vectors were assessed in particular.

Tissue staining-- Parthasarathi et al. (1966) reported that certain tissue stains were useful in the diagnosis of sandalwood spike disease. Diseased tissue took a distinctively different color specific to infection with spike-causing MLO's than did healthy tissue, or tissue infected with other types of disease organisms. Mann's stain, carbolthionin, and Giemsa stain were prepared according to the general formulas given by Parthasarathi et al. (1966) and tissue sections from twigs of both diseased and healthy Dodonaea plants were treated.

Electron microscopy-- Observation of MLO bodies directly in diseased phloem tissue, and failure to observe these organisms in healthy tissue, is accepted as conclusive evidence, supported by indirect indications such as those listed above, of an MLO-caused disease. Tissue samples from dwarfed, yellow leaves, leaf petioles, and twigs of brooms were collected and immediately sectioned and fixed in gluteraldehyde in the field. Healthy tissue from trees with disease symptoms on other branches, as well as from entirely normal-appearing trees, was similarly sectioned and fixed as control material. Standard embedding and ultra-sectioning procedures were followed, and phloem cells were inspected for MLO bodies with the transmission electron microscope. Electron micrographs of MLO's from other studies were used for reference.

Mites-- We placed healthy, potted Dodonaea saplings grown from seed in the greenhouse near the base of severely diseased trees in the field such that the foliage of the healthy plants was intermingled and in contact with that of the diseased trees. It was necessary to transport water to these plants on a frequent basis. Freshly collected diseased plant material was also submitted to University of Hawaii Entomology Department mite specialists for examination early in this project. Eriophyid mites of unidentified species were eventually located. Mites were individually transferred to healthy potted Dodonaea seedlings (15 cm tall) grown from seed in the greenhouse. Plants were either infested with about the same number of mites per unit area as occurred on diseased tissue from the field, or with numbers well in excess of what was considered to be a normal population. This was done to determine possible differential feeding effects and to insure some plant response. Infested plants were then maintained in either the greenhouse or at field conditions in an isolated growth chamber for observation.

Results

According to our assessment, none of the diagnostic approaches pursued thus far for the apparent Dodonaea yellows disease has yielded conclusive results.

Fertilization, either by stem injection or by addition of fertilizer solution to the root zone soil produced no noticeable effect on diseased plants, although in some cases surrounding vegetation responded to soil amendment. Treated Dodonaea plants produced little or no new growth and continued to decline. No tendency toward correction of the yellowing symptom was visible. One of the treated plants was completely dead approximately 3 years following the fertilizer treatments. The other plants, while not declining to the point of death, are stunted and show no symptom correction.

We did not observe definite symptom remission as demonstrated by production of new healthy growth from witches' brooms following either the dry heat or the hot water treatments. Dry heat treatment at 53°C for 5 hours in the laboratory oven caused some defoliation followed by recovery; whereas 58°C resulted in death. However, the diseased plant was killed by the 5-hour 50°C exposure, perhaps due to stress from transplanting or the disease itself. Temperatures and duration of the dry heat treatment in the field obviously approached the tolerable limit of the plant since at least one branch was killed by the heat exposure. Comparisons among direct observations and photographs taken before and after the dry-heat treatment did appear to show a tendency toward color correction. However, we cannot consider this observation entirely conclusive since slight variations in light quality and exposure of photographs taken before and after treatment could have falsely indicated a treatment effect. Recent observations made 3 years following dry heat treatment indicate that, although most portions have remained alive, the

plant is severely diseased and remains stunted. Thus, any actual effect of heat exposure in neutralizing the disease agent were only slight and temporary.

Reduction of yellowing by hot water treatments was slight, if this occurred at all, such that no positive conclusion could be drawn. Hot water exposure caused a whitish cast on the waxy surface of both diseased and healthy leaves which made comparisons among slight color changes difficult.

Treatment with either of the tetracycline formulations by stem injection, applying an antibiotic paste to stem wounds, or spraying solutions on the foliage likewise failed to allow production of new, normal-appearing growth from diseased areas which could definitely be attributed to the antibiotic application. A tendency toward correction of yellowing was noted in some plants treated with Terramycin paste applied to stem wounds. However, consistent production of such results would be necessary to be considered conclusive.

Stem injection with higher concentrations of Terramycin resulted in leaf vein blackening and black flecking in some diseased plants. This reaction to the antibiotic demonstrated the efficiency of the stem injection method in delivering material into the vascular stream, however.

We collected a variety of insects, including several leafhopper species, from Dodonaea foliage. Our sampling did not indicate occurrence of large, seasonal influxes of any particular species, however, that would appear to correspond with the prevalence of the disease. Usually only small, probably constant populations of each species were found.

Tissue staining procedures resulted in some color differentiation among samples. However, these did not always appear to be consistent between known diseased and healthy tissue and may have resulted from variations in the tissues themselves rather than from physiological alterations caused by infection as compared with tissue from normal plants.

Inspection of phloem cells by electron microscopy failed to reveal bodies resembling the MLO's identified in micrographs from other plants known to have MLO-caused diseases. Apparent cellular aberrations were also observed in tissues from apparently normal plants.

The possibility that disease symptoms may result from toxins injected by mites was likewise not substantiated by our investigations. Potted plants placed in contact with diseased plants in the field remained healthy for approximately 6 months until they were allowed to dry out. Although initial examinations failed to reveal mites of types that could cause the observed symptoms, eriophyid mites, which are small, slow moving, and relatively obscure, were later discovered. However, none of

the healthy seedlings to which mites were transferred developed visible abnormal or detrimental reactions of any kind after several weeks of observation. This was true of both the plants infested with an estimated normal mite population and those infested with excessive populations. Although mites of this type are difficult to locate on plant tissue, careful examination of infested seedlings at daily and weekly intervals indicated that mite populations on infested plants steadily declined, with no apparent reproduction, until they could no longer be found. Furthermore, even though earlier information indicated that eriophyid mites were associated only with diseased tissue, recent critical examination of healthy Dodonaea twigs revealed the presence of similar unidentified mites of this type. These mites appeared from noncritical examination to be indistinguishable from those on diseased tissue.

Discussion

Notwithstanding the lack of conclusive evidence that the Dodonaea condition is caused by MLO's, we do not rule these organisms out as the inducers of this apparent yellows disease. Priority constraints necessitated limiting our investigations to only the most straightforward approaches. Certain potential approaches including transmission of MLO's among plants by grafting and by dodder (Bowyer et al. 1969) and through sap (Nayar 1967) were not attempted. Although sap transmission may initially appear to be a simple, straightforward procedure, this approach frequently had been attempted prior to Nayar's (1967) report without positive results (Bowyer et al. 1969).

Thus, many avenues remain to be pursued before definite conclusions can be reached concerning the etiology of this disease. As mentioned in literature reports, and especially in personal communication with other investigators of MLO-induced diseases, several factors, such as genetic variability among individual plants, plant age, phenological state, season of the year, and concentration of disease agents within particular tissues may influence the nature of results. Due to these factors, diagnosis of yellows diseases, while quite definite and straightforward in some cases, may be an elusive process in others.

According to J. L. Dale (personal communication) wide variation in MLO concentration may exist among cells themselves in diseased tissue, necessitating exhaustive searches within and among many samples. Age of infection may also be an important factor. The possibility exists that MLO's are present in very early stages, perhaps even preceding display of recognizable symptoms. If this is true, our investigations of tissue showing definite symptoms occurred after MLO's were no longer present.

Low concentrations of MLO bodies in infected tissues, whether accompanied by symptoms or not, may not be visible in observation attempts with electron microscopy even though they

may be present, and may likewise not respond readily to other diagnostic measures such as antibiotic or heat treatments.

Our failure to discover obvious leafhopper vectors is perhaps a result of infrequent sampling. Dodonaea stands may profitably be sampled on a weekly or biweekly basis throughout the year, or even for several years since insect populations are known to fluctuate cyclically from year to year. It is possible that new infections correspond with such fluctuations in vector populations, but become noticeable in a less consistent manner. Furthermore, leafhoppers which we did collect were not caged on healthy plants to ascertain their ability to transmit the disease. The possibility exists that, although the disease would more likely appear to be transmitted by large insect populations, symptoms could result from transmission by smaller, constant leafhopper populations. Again, a testing program involving frequent sampling from various Dodonaea sites and testing of collected insects on healthy plants was considered beyond the practical scope of our resources and time commitment.

Although the role of eriophyid mites in inducing leaf dwarfing, yellowing, and brooming on Dodonaea is not completely understood, results of our investigations tend to detract from the consideration of these organisms as the causal agents. The lack of any visible effect, even by the excessive numbers of mites with which some seedlings were infested, and the presence of similar-appearing eriophyid mites on healthy plants from the field support this conclusion. The apparent unsuitability of Dodonaea seedlings for mites that had been transferred from Dodonaea plants in the field is not understood, however, and may be of some significance in this study. Perhaps test plants corresponding more nearly in size and age to the smallest infected plants observed in the field should have been used in the event that seedlings produce a metabolite unfavorable to mites. Notwithstanding this possibility, we would assume that any visible detrimental effects associated with mites would have become evident following the early feeding activities observed among newly transferred mites, particularly those in excessive numbers.

The uncertainties surrounding Dodonaea disease etiology illustrated in this study present several avenues for further study. Aside from these unsolved aspects, however, our overall observations indicate the apparent transmissibility and progressive nature of this condition. It is difficult to know at this time whether we are observing a segment of a long term, more or less stable disease cycle, or whether this is a relatively new disease in Hawaii which is increasing in prominence. The apparent absence of any previous record of this condition, however, is rather surprising and may be of significance in considerations of this disease.

Acknowledgements

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FUTURE MEETINGS

ICSEB - III

THIRD INTERNATIONAL CONGRESS OF SYSTEMATIC
AND EVOLUTIONARY BIOLOGY, 1985

The Congress will be held on 4-10 July 1985 at the University of Sussex, near Brighton, England. It is sponsored by the Royal Society, British Ecological Society, Linnean Society, Palaeontological Association and Systematics Association.

The major aims of this Congress, as with its highly successful predecessors in Boulder, Colorado (1973) and Vancouver (1980), are to encourage and facilitate the integration of the work of biologists in adjacent or over-lapping fields in the general area of systematic and evolutionary biology.

The programme will include a number of symposia devoted to specially-selected broad interdisciplinary themes, with invited speakers. The proposed subjects include:

Symbiosis in Evolution; Conservation of Tropical Ecosystems; Biogeographic Evolution of the Malay Archipelago; Adaptation Aspects of Physiological Processes; Co-evolution in Ecosystems and the Red Queen Hypothesis; Angiosperm Origins and the Biological Consequences; The Measurement of Rates of Evolution; Molecular Biology and Evolutionary Theory; Co-Evolution and Systematics; Molecules vs. Morphology in Phylogeny : Conflict or Compromise? Random and Directed Events in Evolution; Biochemical Innovation in Microbial Communities.

There will also be a full provision for intending participants to suggest and arrange symposia of special interest to particular groupings of biologists. Other sessions will provide opportunities for the presentation of papers concerned with particular topics or groups of organisms. There will also be a number of poster sessions.

Accommodation and meals will be available on the campus of the University of Sussex. In addition, hotels are available in nearby Brighton, an attractive historic resort town on the South Coast.

Further information will only be sent to those who request it. Anyone wishing to be placed on the mailing list, or to suggest topics for Special Interest Symposia, or to contribute to any of the Congress Symposia listed above, should write to:

Professor Barry Cox,
c/o ICSEB Congress Office,
130 Queen's Road,
Brighton, Sussex BN1 3WE

ANNOUNCEMENT OF THE
SYMPOSIUM ON
PROTECTION AND MANAGEMENT OF
TERRESTRIAL HAWAIIAN ECOSYSTEMS
AND
FIFTH CONFERENCE
IN NATURAL SCIENCES

Hawaii Field Research Center
Hawaii Volcanoes National Park
Hawaii
June 5-7, 1984

The National Park Service, U.S. Fish and Wildlife Service, Cooperative National Park Resources Studies Unit, University of Hawaii, and the Hawaii Natural History Association invite you to a Symposium on the Protection and Management of Terrestrial Hawaiian Ecosystems and the Fifth Conference in Natural Sciences at Hawaii Field Research Center, Hawaii Volcanoes National Park.

The Symposium will be held June 5-6. Papers are by invitation only. A tentative agenda is appended.

Dormitory accommodations, including kitchen facilities, but not bedding, will be available at the Research Center and at Magma House on a first-come, first-served basis through the Research Center. The cost is \$5.00/night/person. Additional housing is available at Volcano House (range \$37-\$48/double), Namakani Paio campground cabins (\$14.56/4 persons), and Hilo (range \$20-\$50/double). Reservations should be made well in advance directly with Volcano House or the appropriate hotel.

An informal dinner will be held Wednesday, June 6, if there is enough interest. Price will be announced at the meeting.

A registration fee will cover copies of the agenda, abstracts, and proceedings for the Natural Science Conference. The Symposium proceedings will be published separately at a cost to be announced later. The registration fee will be \$15 prior to May 1 and \$20 after that date.

Symposium: PROTECTION AND MANAGEMENT OF TERRESTRIAL HAWAIIAN ECOSYSTEMS.

Co-Conveners: C.P. Stone, NPS
J.M. Scott, USFWS

Tues., June 5 I. Native Biota: Status, Research and Management Needs

Session Chair: S. Mountainspring, USFWS

- | | | |
|-------|--|------------------------------------|
| 8:30 | A. Native Ecosystems - | J. Jacobi (USFWS) |
| 9:10 | B. Native Plants - | W. Wagner (BPBM) |
| 9:50 | C. Native Birds - | J.M. Scott,
C.B. Kepler (USFWS) |
| 10:30 | COFFEE | |
| 11:00 | D. Native Invertebrates - | W. Gagne (BPBM) |
| 11:40 | E. Preserves, Parks,
Reserves, Natural Areas:
Political and Social
Considerations - | A. Holt (TNC) |
| 12:20 | LUNCH | |
| 2:00 | Highlights of Session I - S. Mountainspring | |

II. Exotic Biota: Impacts, Research and Management Needs

Session Chair: R.L. Walker, DOFAW

- | | | |
|------|--|----------------------|
| 2:15 | A. Exotic Invertebrates - | F. Howarth (BPBM) |
| 2:55 | B. Exotic Plants - | C.W. Smith (UH) |
| 3:35 | COFFEE | |
| 4:05 | C. Exotic Vertebrates - | C.P. Stone (NPS) |
| 4:45 | D. Exotic Avian Diseases - | C. Van Riper III(UC) |
| 5:25 | Highlights of Session II - R.L. Walker | |
| 5:40 | ADJOURN | |

Wed., June 6 III. Ecosystems Monitoring, Restoration and Management

Session Chair: S. Conant, UH

- | | | |
|-------|---|----------------------------|
| 8:30 | A. Exclosure Studies - | L.L. Loope (NPS) |
| 9:10 | B. Ohia Dieback - | D. Mueller-Dombois
(UH) |
| 9:50 | C. Restoration of Native
Ecosystems - | C. Lamoureux (UH) |
| 10:30 | COFFEE | |
| 11:00 | D. Preserve Design: Size,
Shape and Distribution - | J. Franklin (USFS) |
| 11:40 | E. Preserve Design: Genetics
and Minimum Population
Sizes - | C. Schonewald-Cox |

(NPS)

12:20 LUNCH
2:00 Highlights of Session III - S. Conant

IV. Current and Future Roles of Agencies,
Conservation Groups, Legislature and
the Public in Preserving and Managing
Hawaiian Ecosystems

Session Chair: C.B. Kepler

2:15	1. USFWS -	P. Stine
2:30	2. NPS -	B. Harry
2:45	3. State -	L. Landgraf
3:00	4. TNC -	K. Taketa
3:15	5. Private Landowner -	H.P. L'Orange
3:30	COFFEE	
4:00	6. Government -	A. Chang
4:15	7. Conservation Groups -	C. Lamoureux
4:45	Highlights of Session IV -	C.B. Kepler
5:00	Reactions to, and Comments on, Symposium (Discussion)	-J.M. Scott, C.P. Stone
5:30	ADJOURN	

BLACKBERRIES

As part of an investigation on the biological control of the exotic blackberry so prevalent around our state, it was necessary to confirm the identity of the species. St. John (1973) in his List and Summary of the Flowering Plants of the Hawaiian Islands (Pacific Trop. Bot. Gdns. Mem. #1) lists Rubus penetrans L.H. Bailey. Specimens, so identified by Dr. St. John, had also been forwarded to the Southeastern Forest Experiment Station in Olustee FA for propagation as hosts of several rust fungi. (These fungi are being evaluated as biological control agents for the local blackberry). Some cuttings of the blackberry were also forwarded to Dr. David W. Hall at the University of Florida in Gainesville. He identified it as Rubus argustus Link.

The taxonomy of our local blackberry obviously needs clarification and the problem is brought to the Society's attention. Perhaps someone has some further information which could help us resolve this problem.

Don Gardner, CPSU/UH

P.O. Box #124
Kailua-Kona, HI
96740

Editor. Hawaiian Botanical Soc. Newsletter

Dear Editor,

Has anyone found Ma`o occurring on the island of Hawaii?

There seems to be a rumor that the native Ma`o, Gossypium tomentosum has recently been collected growing naturally on Hawaii. And this may be true. And for a good reason.

During my nearly 60 years of botanizing on Hawaii I have never found this plant growing naturally. I have talked with the late Amy Greenwell, Isa and Otto Degener as well as others and they too had never collected it growing naturally on Hawaii. In 1963 I received a letter from Dr. S. G. Stephens who was spending a semester on the Manoa campus as an exchange Prof. He was greatly interested in Mao and stated, "that he could find no record of Mao growing naturally on Hawaii." Rock, as far as I know does not mention it. Hillebrand does and he stated, "that Mao is found along the seacoast on all islands". MacCaughy 1917, "Vegetation of Hawaiian Lava Flows covering Maui and Hawaii" does mention finding Mao but failed to indicate on which island. According to St. John, "Pacific Science, Vol. 32, Nov. 3, 1978" it may be that Mao was collected for the first and perhaps the only time growing naturally on Hawaii by David Nelson in 1779.

I secured seed of Mao from Maui thru the late David Fleming in 1952. We raised plants from this seed at the old Hilo Tree Nursery and distributed them to those interested. Some were planted at the MacKenzie Park at Malama-ki, Puna at sea level; at Manuka Park, Kau; and elsewhere. 3100 ft does seem rather high for a sea coast plant but they grew and in two years produced fertile seed. Some few years later in company with Isa and Otto Degener I collected additional seed on Oahu. From this seed I produced several plants one of which I have growing here in my yard in Kona at sea level. This plant has grown well and produced hundreds of seed. These I have planted and given away the resulting plants to those interested. In addition I have broadcasted Mao seed from Kailua north to the 1859 Lava Flow and south to Kealahou Bay. All along the sea coast. Perhaps, (I hope) that some of these plants and seeds have become established and perhaps some collector will find them growing as a result of their actions.

Sincerely,

L. W. W. Bryan

HAWAIIAN BOTANICAL SOCIETY
Report of the Treasurer
December 1, 1982 - November 30, 1983

Receipts:		
Dues	\$1,378.50	
Gifts	140.00	
Interest	1,157.67	

		\$2,676.17
Expenditures:		
Postage	\$ 312.95	
Office supplies	115.87	
Donations	1,900.00	
Xerox fees	23.40	
Newsletter publication	990.34	
Science fair	86.24	
Meeting room fees	31.00	

		\$3,459.80

Cash flow:		(783.63)
Net worth of the Society:		
December 1, 1982		\$16,832.76
Change: Dec. 1 - Nov. 30, 1983		(783.63)
November 30, 1983		16,049.13
Bank balances:		
First Hawaiian Bank - checking account:		
Balance December 1, 1982	\$2,050.18	
Balance November 30, 1983	-0-	(\$2,050.18)

Honolulu Federal S & L - checking account:		
Balance December 1, 1982	-0-	
Balance November 30, 1983	2,157.34	2,157.34

First Federal S & L - account #102586:		
Balance December 1, 1982	213.14	
Balance November 30, 1983	-0-	(213.14)

First Federal S & L - account #111764:		
Balance December 1, 1982	440.56	
Balance November 30, 1983	465.47	24.91

First Federal S & L - account #c-718689:		
Balance December 1, 1982	14,128.88	
Balance November 30, 83	13,426.32	(702.32)

Change in bank balances:		(783.63)

Respectfully submitted,
Derral Herbst

Minutes of the June 6, 1983 Meeting

President Sohmer called the meeting to order at 7:30 pm. The May minutes were read, amended and approved. Derral Herbst gave the Treasurer's report as follows:

Balance as of May 1.....	\$2,035.17
Dues.....	123.50+
Gifts.....	12.50+
Postage.....	130.00-
Science Fair.....	85.00-
Balance as of May 31.....	\$1,956.17

The Conservation Committee reported the following updates on several botanical-political issues.

- 1) President Sohmer has volunteered to write a letter to the Governor, urging him to put these monies to good use on the control project. The appropriations for the Endangered Species Act have been held up. In addition, the number of species considered for endangered status has dropped from 70 to 7. Financially this means a cutback from a previous budget of several million dollars to zero.
- 2) The federal government will contribute no funds for the Fish and Wildlife land purchase project.
- 3) The state funds appropriated for control of banana poka (*Passiflora mollissima*) have not been utilized. Since this is a subject of general concern to the society, it was suggested at Executive Board that the HBS correspond their position to the Governor and President Sohmer said he would draft a letter.
- 4) The proposal for commercial development (hotels) in the Queen's beach area has been removed from consideration. However, public hearings are coming up on residential development in the area, so

Steve Montgomery reported the following items for the Native Plants Committee:

- 1) The State Department of Agriculture has proposed (in Update) that the weed problem in the State (*Heliconia*, *Melastomataceae*, and others) needs recognition. One way this growing problem could be more accurately assessed is by updating the list of exotic and noxious weeds.
- 2) Also noted as a problem species was koa haole (*Leucaena leucocephala*). Publication of portions of Ray Fosberg's informative paper could foster public awareness about this weedy species.

There was no report from the Membership Committee. The

Newsletter Committee indicated that the 1982 Newsletter (one issue for the year) was at the printers.

Under Old Business, a memo was received from the Trustees of the Marie Neal Fund, indicating that the motion brought before the membership requesting funds for the purchase of conservation easement on Waikamoi Reserve was reviewed and approved.

Under New Business, Steve Montgomery made a motion that the Society support the Department of Agriculture initiative to place the family Melastomaceae on the noxious weeds list and that this list be published so that all nurserymen are aware of it. The letter of support should be directed to Jack Suwa, who is the Chairman of the Department of Agriculture.

Mr. Montgomery also made a motion that Fosberg's koa haole paper be forwarded to the editor of the Leucaena Newsletter, and that a memo be added suggesting that this species not be introduced on any oceanic island on which it is not already growing. Some discussion followed the motions and it was suggested that such a memo be first published in our own Newsletter.

Also under New Business, Faith Roloeffs announced that there are now two hiking books available, one edited by Ray Tabata for Manoa Cliffs Trail and the other a guide for the Makiki Loop Trail.

Our Plant of the Month Speakers were Earl Zablackis and George Linney. Earl talked about a new species of the red alga Scinaia that he has been studying. George's subject was color variation in greenhouse grown Dionella, or Uki Uki (pulled reed).

Our Speaker of the Month was Dr. Warren Wagner who gave a slide presentation on deserts in North America, the Great Basin, the Chihuahuan, and the Sonoran deserts.

Respectfully submitted,
Kristen Schlech

Minutes of the October 3, 1983 Meeting

The meeting was called to order by Vice-President Funk at 7:30 pm. The Treasurer's report, covering the months of June-September, is summarized as follows: The June minutes were read and approved.

The Conservation Committee reported the following items:

- 1) The Waikamoi Reserve easement purchase was a success. The Nature Conservancy is now attempting to raise the \$500,000.00 necessary to man the preserve.

- 2) The Banana poka control funds are being utilized - several project people have been hired.
- 3) The Queen's Beach development bill is still on the books, with residential zoning still a possibility.
- 4) The Forestry Department is worried about fires, particularly in areas of Kauai that are inhabited by the Kikuyu grass (Pennisetum clandestinum), an aggressive invader of areas previously covered by native vegetation.
- 5) A full EIS for the Farms of Kapua development should be forthcoming. Objections were made on behalf of the Society to the previously filed negative declaration covering 6,100 acres of Conservation land.
- 6) A revision is needed on the definition of what constitutes critical habitat.

The report of the Native Plants Committee noted the October 13 deadline on the consideration of Kokia drynarioides, Panicum carterii, Bidens cuneata and Schidea adamantis as endangered plants and also stated that the exceptional trees bill (City and County of Honolulu) has been passed on to Winona Char for revision.

The following announcements were made:

- 1) The letterhead has been ordered with a slight change in the green color, as requested.
- 2) Next month is plant exchange month.
- 3) At the Waikiki Aquarium on Thursday (Oct 6) is a lecture on Acid Rain--Requiem or Recovery? This talk is accompanied by a fairly controversial film, made in Canada(?) which has not been previously released in the United States.

The Plant of the Month speaker was Chris Simon, who spoke on hau (Hibiscus tiliaceus) and the distribution of this species in subtropical areas. She noted the lack of information about the pollination mechanisms of this species in Hawaii and compared the glands found on ant-pollinated hau in Central America and the glands found on the Hawaiian species.

The Speakers of the Month were Dr. Isabella Abbott, Jane Lewis and Bill Brostoff who showed slides of their trip to Mainland China for the 12th International Seaweed Symposium. Slides of the agricultural landscapes, as well as city life, illustrated a variety of plants and plant products found in Mainland China, both aquatic and terrestrial.

Respectfully submitted,
Kristen Schlech

HAWAIIAN BOTANICAL SOCIETY
Report of the Treasurer
June - Sept. 1983

Balance as of June 1 \$2,077.17

Receipts

Dues	\$ 234.00
Transfer from Marie Neal Fund	1,800.00
Transfer from closed saving account	222.09

	2,256.09

Expenditures

Donations	\$1,800.00
Office supplies	22.95
Newsletter publication	171.86
Postage (& insur.)	64.82
Meeting fees	31.00
Xerox fees	16.25
Engrave Science fair trophy	6.24

	2,113.12

Balance as of September 30 \$2,220.14

Minutes of the November 7, 1983 Meeting

The meeting was called to order at 7:30 pm by Vice-President Funk, as President Sohmer is in Papua New Guinea. There were no guests, and the Treasurer's report was given by telephone as Treasurer Herbst was unable to attend the meeting. The Secretary read the minutes which were accepted as read.

Wayne Gagne gave the following updates for the Conservation Committee:

- 1) Maui is greatly in need of water purification. It is probable that the source of water contamination is the feral pig damage in the watershed on Haleakala's north slope.
- 2) The Sierra Club and Greenpeace have begun work on the assessment of what constitutes critical habitat for the Hawaiian Monk Seal, similar drafts of the definition of critical habitats should be considered for other sensitive species.
- 3) EIS has been required for the Kapua Farms development (South Kona).

The Native Plants Committee reported they were reassessing the proposed significant trees bill and Winona Char and Carolyn Corn were compiling a response to send to Councilwoman Bornhorst.

The Membership Committee chair, Karen Asherman, reported that the Society had a membership of 151, and reminded the general membership that the dues notices go out in December.

The Newsletter Committee indicated that, per C. W. Smith-Editor, the copy for the next issue was ready to be typed.

Under New Business, Vice-President Funk reported that a nominating committee had been formed by Dan Palmer and Winona Char, who presented the following slate for proposed officers:

President: Evangeline Funk, Department of Botany, U.H.

V. President: Chris Simon, Department of Entomology, U.H.

Secretary: Jane Lewis, Department of Botany, U.H.

Treasurer: Derral Herbst, Office of Endangered Species,
U.S. Fish and Wildlife Service

Directors: Rylan S. N. Yee, Department of Botany,
B. P. Bishop Museum

Sy H. Sohmer, Department of Botany,
B. P. Bishop Museum

Dr. Sohmer declined the nomination and Ms. Cheran Wilson accepted.

Under announcements, Vice President Funk stated that the December meeting will take a slightly different format, beginning a little earlier, at 7:00 pm instead of 7:30, and prefaced by a "hearty" pupu hour, followed by a short business meeting, and then a potpourri slide show of places or plants the general membership has seen in 1983.

There was no Plant of the Month Speaker. Our Speaker of the Month was Dr. James Brewbaker from the U.H. Horticulture Department, who spoke on a most relevant topic: Economically Important Nitrogen Fixing Tree Species Planted in Hawaii.

Respectfully submitted,
Kristen Schlech, Secretary

HAWAIIAN BOTANICAL SOCIETY
Report of the Treasurer
November 7, 1983

Balance as of October 1: \$2,220.14

Receipts

Interest: 6.94

Dues: 7.50

\$14.44

Expenditures

Office supplies: 4.00

Postage: 19.25

\$23.25

Balance as of October 31 \$2,211.33

ANNUAL REPORT OF THE SECRETARY FOR 1983

1983 marked significant changes for the Hawaiian Botanical Society. As the Society moved into its sixtieth year, the membership increased from 115 to 151, with 22 honorary members, the newsletter became current, and the Society's finances were expertly managed and invested in numerous constructive endeavors. The monthly meetings, in addition to addressing many of the critical conservation issues at stake last year, provided many outstanding lectures and presentations.

The year kicked off with John Ford's (USFW) lecture on the life cycles of Hawaii's fresh water fauna, February was highlighted with the remobilization of the newsletter team, and by March the Society was up to its elbows in the Geothermal issue--which resulted in a letter submitted to the legislature (Sen. Cayetano) outlining the Society's concern over the effects of tapping geothermal energy in pristine areas.

In April the Society voted on an amendment to its By-Laws, which tlined the appropriate channels for expenditure requests. In essence the amendment states that all financial requests be submitted for approval to the executive Council before being submitted to the members for voting.

May was highlighted with Chip Wickman's entertaining presentation on stalking the elusive Brighamia, and Dr. Lamaroux's interesting aerial post-mortem of Hurricane Iwa damage on Kauai. The month was also one of goodwill; \$100.00 was given to the Maui Zoo and Botanical Garden, Pacific Tropical Botanical Garden and the Wau Ecology Institute from the Society's general funds, and a special donation of 1500.00 was made from the Marie Neal Fund to the Nature Conservancy for purchase of 5 acres of the Waikamoi Reserve on Maui.

Just prior to summer adjournment the Society addressed the disappearance of the funding for the Banana Poka Project, the temporary victory of the zoning of Queen's Beach, which prohibited the development of a hotel complex on top of some of Oahu's few remaining native strand plant communities. Increased awareness of Leucaena was also a topic, and the interest generated by the discussion culminated in the Society's November speaker, Dr. Brewbaker who lectured on economically important nitrogen fixing tree species in Hawaii.

By October, banana poka had been marginally refunded, the Waikamoi purchase was a complete success, and the Queen's Beach area once again the focus of avaricious interests--this time for residential zoning. The Botanical Society again revised the exceptional trees bill proposed by Councilwoman Bornhorst, and discussed the rapidly colonizing Penisetum weed in fire disturbed areas. Our speakers of the month were the phycology contingent, Dr. Abbott and two graduate students, Jane Lewis and Bill Brostoff, who had all returned from the 12th International Seaweed Symposium in China.

November brought a new slate of officers, with Evangeline Funk as President, Chris Simon as Vice President, Derral Herbst continuing as Treasurer, and Jane Lewis as recording and corresponding secretary. The Society asked Rylan Yee (Dept. of Botany, BISH) and Cheran Wilson to join the Executive Committee as Directors. The slate was unanimously voted on at the December Annual meeting, which successfully closed the year with a pleasant party and slide show coordinated by Evangeline Funk. All in all, a good year for the Society-- keep on the good work!

Respectfully submitted,
Kristen Schlech, Secretary 1982-84

ECONOMICALLY IMPORTANT NITROGEN FIXING TREE SPECIES
PLANTED IN HAWAII

(James L. Brewbaker and Brian K. Styles, eds.)
Prepared for Bellagio Workshop; Document #2A)

Nitrogen is frequently a limiting factor in tropical ecosystems. Nitrogen fixing plants can therefore contribute significantly to improving tropical soils. The Bellagio workshop identified 44 species in this list, of which the following occur in Hawaii. Code to information:

SPECIES (FAMILY)

1. ORIGIN; HEIGHT, SHAPE
2. USES AND CHARACTERISTICS
3. ADAPTATION (INCL. MIN. RAINFALL)
4. COMMENTS, CHROMOSOME NO.

Acacia auriculiformis A. Cunn. Ex Benth.

(Mimosoideae; Leguminosae)

(Found only sporadically, and in experimental studies)

1. Australia, New Guinea; to 30m, spreading
2. Fuelwood, pulpwood; .68 sp.gr.; 15 m³/ha/yr
3. Wide adapt., acid soils; humid tropics (750 mm. min)
4. Not too tolerant of drought? fire? winds? 2n=26

Acacia confusa Merr. (Mimosoideae; Leguminosae)

(Formosa koa)

1. Philippines, Taiwan; to 14 m, spreading
2. Firewood (high sp. gr.), ornamental
3. Wet subtropics (to 750 mm min), acid soils
4. Slow growth 2n=26

Acacia farnesiana (L.) Willd. (Mimosoideae; Leguminosae)

(klu, kolu, aroma, popinac)

1. Tropical America; to 10m, often shrubby
2. Fuelwood; forage, tanning; perfume from flowers; ornamental; black dye used to make ink
3. Dry tropics; wide variety of soils
4. Very thorny; can be weedy 2n=52

Acacia mangium Willd. (Mimosoideae; Leguminosae)

(In experimental trials only)

1. Australia and Papua New Guinea, Indonesia; to 30m, erect, stately
2. Timber (.65 sp gr), Firewood?, to 30 m³/ha/yr
3. Moist tropics (to 1000 mm min), acid soils?
4. Insects on leaves, genetic variability

Acacia mearnsii Willd. (Mimosoideae; Leguminosae)

(black wattle)

1. Australia; to 25 m, spreading
2. Fuelwood, charcoal, tannins; dense wood (.75 sp.gr.), to 25 m³/ha/yr
3. Moist sub-tropics, mid elevations; to 800 mm min?
4. Can become weedy 2n=26

Acacia nilotica (L.) Willd. Ex Del. (Mimosoideae; Leguminosae)
(Thorn tree)

1. Africa and India; to 20 m, usually less
2. Firewood, charcoal, fodder (pods, leaves), tannin and gum
3. Dry tropics (but thrives under irrigation)
4. Extremely thorny, variable 2n=52,104

Albizia falacataria (L.) Fosberg (Mimosoideae; Leguminosae)
(albizia, moluccan sau)

1. Indonesia, New Guinea; to 45 m
2. Pulpwood, soft, .33 sp.gr., moldings, boxes, soil improvement
3. Moist tropics (to 1000 mm min), midlands
4. Soft wood, poor fuel (=A. moluccana)

Albizia lebbek (L.) Benth. (Mimosoideae; Leguminosae)
(sirís tree, white monkeypod, womans tongue)

1. Tropical Asia and Africa; to 30 m
2. fuelwood (high value, 5200 kcal/kg), foliage for feed, yields to 5 m³/ha/yr, furniture
3. Wide adaptability, dry and moist tropics (to 600 mm min)
4. Slow growth 2n=26

Alnus nepalensis D. Don (Betulaceae) (Nepal alder)

1. Himalayas; to 30m height, 40cm dia.
2. Firewood but sp.gr. .35; utility timber and forage
3. Cool tropic highlands to 3000m, mesic (800 mm min?)
4. Some insects, mistletoe; wood is soft 2n=28

Cajanus cajan (L.) Millsp. (Papilionoideae; Leguminosae)
(Pigeonpea, pi-nunu)

1. India, Africa, 3-5 m, shrubby
2. Food ("pigeon pea" beans), firewood, green manure, forage
3. Dry to mesic tropics (400-1500mm), wide adaptability
4. Short-lived perennial (disease-restricted?) 2n=22

Calliandra calothyrsus Meissn. (Mimosoideae; Leguminosae)
(kalyandra; in experimental trial only)

1. C. and S. America; to 8 m, shrubby
2. Firewood; green manure and forage; sp. gr. .65
3. Moist tropics (min. 1000mm), cooler (above 500m?); to 40 m³/ha/yr with annual harvest
4. Poorly digestible forage (=C. confusa Sprague & Riley) 2n=22

Casuarina cunninghamiana Miq. (Casuarinaceae)

1. Australia, to 35 m
2. Firewood, sp. gr. .7; shade tree; river bank stabilization
3. Cool tropics to warm temperate; 500 mm min.
4. Can be weedy (Florida) 2n=18

Casuarina equisetifolia L. (Casuarinaceae)
(ironwood, she oak, beefwood, toa)

1. Australia and Pacific Isl. to India; to 35 m

2. Firewood, charcoal; "best in world"; sp. gr. 1.0, windbreak; timber for postwood
3. Warm tropics, coastal areas; typhoon tolerant, very saline tolerant; very saline tolerant
4. Coppices poorly?

Casuarina glauca Sieb. Ex Spreng. (Casuarinaceae) (swamp oak)

1. Australia (N.S.Wales to Qld.); to 20 m
2. Firewood, charcoal, fencing, piles for seawater, windbreaks in coastal areas; sp.gr. .98
3. Warm temperate to subtropics, coastal areas; salt-tolerant; heavy clay soils
4. Produces root suckers and can be weedy (e.g. Florida)

Dalbergia sissoo Roxb. (Papilionoideae; Leguminosae) (sissoo)

1. Indian subcontinent; to 30 m
2. Lumber, fuelwood, sp gr. .68
3. Warm tropics, mesic or arid (to 500 mm min); fast growth for a Dalbergia, slow by other standards
4. Slow growth 2n=20

Erythrina fusca Lour. (Papilionoideae; Leguminosae)

1. C. & S. America, to 30 m; broad crown
 2. Shade for coffee and cacao; live fenceposts; soft wood
 3. Lowland moist tropics to 1500 m; often in swamps or on poorly drained clayey soils
 4. Fast growth; effective green manure; easily cloned 2n=42
- One columnar variety ("fastigiata")

Erythrina poeppigiana (Walpers) O.F.Cook
(Papilionoideae; Leguminosae)

1. S. America to Panama; to 40 m
2. Shade for coffee, ornamental; soft wood; paper pulp; forage, mulch; living fences
3. Dry to mesic tropics, to highlands
4. Fast growth; coppices and clones easily; thorny

Gliricidia sepium (Jacq.) Walp. (Papilionoideae; Leguminosae)
(madre de cacao)

1. S. and C. America; small tree to 10 m
2. Firewood, timber, sp. gr. .75, fodder, green manure, shade, ornamental; easily propagated by cuttings, living fence, to 8 m³/ha/yr
3. Dry to humid tropics (1000 mm min), also saline areas
4. Toxic bark/seeds/roots; aphids on foliage (=G. maculata) 2n=20

Intsia bijuga (Colebr.) O. Kuntze (Caesalpinioideae; Leguminosae) (ipil)

1. Southeast Asia, E. Africa, India; to 40 m, buttressed
2. Handsome timber, decking, truck bodies ("ipil" in Philippines), highly resistant to rot; slow growth
3. Moist tropics, prob. 2000 mm min;
4. Genetic variability 2n=24

Leucaena diversifolia (Schlecht) Benth. (Mimosoideae; Leguminosae) (pink leucaena; research trials only)

1. C. America, to 18 m (with shrubby variants)
2. Fuelwood (est. .5 sp. gr.), shade, forage
3. Dry to mesic tropics, prob. 500 mm min, to midlands (1500 m)
4. Little studied, great genetic diversity 2n=52

Leucaena leucocephala (Lam.) De Wit (Mimosoideae; Leguminosae) (koa haole, haole koa, ipilipil, lamtoro, subabul)

1. C. America and Mexico, to 18 m (with shrubby variants)
2. Fuelwood, nurse tree, forage, small timber and pulpwood; sp. gr. .55, some food use (pods, seeds, leaves), energy plantations, yields to 50 m³/ha/yr
3. Dry to mesic tropics, 500 mm min, lowland
4. Widely studied 2n=104

Mimosa scabrella Benth. (Mimosoideae; Leguminosae) (bracatinga; in experimental trials only)

1. S.E. Brazil & Argentina; to 12 m, thornless
2. Fuelwood, pulpwood, ornamental; shade for coffee; rapid growth?
3. Mid-elevation cool tropics and subtropics (flourishes t 2400 m, Guatemala)
4. Little studied

Parkia javanica (Lam.) Merrill (Mimosoideae; Leguminosae) (parkia)

1. Indo-Malaysia, Philippines; now widely pantropical; to 40 m, umbrella crown
2. Timber, ornamental, seeds used in local medicine
3. Humid tropics to 1000 mm; 500-700 m elevation
4. Pest-tolerant; protected in Indonesia (also known as P. roxburghii G. Don.)

Parkinsonia aculeata L. (Caesalpinioideae; Leguminosae) (Jerusalem thorn, Mexican palo verde, ratama)

1. Americas; to 20 m, spreading
2. Fuelwood; fodder; ornamental; fences; local medicine
3. Widely adapted, to moist tropical and dry areas, also sandy and saline soils
4. Very thorny; weedy in Argentina 2n=28

Pithecellobium dulce (Roxb.) Benth. (Mimosoideae; Leguminosae) (opiuma, Manila tamarind)

1. C. to S. America, to 20 m, irregular and untidy spreading tree
2. Fuelwood (to 5500 kcal/kg), smoky; forage, construction postwood, shade (thorny hedges), food (pods), some tannin and oil (seeds)
3. Very wide adaptability, from dry to humid tropics and to cooler elevations (So. Florida)
4. Thorny (segregating), poor form 2n=26

Pongamia pinnata (L.) Pierre (Papilionoideae; Leguminosae)
(pongamia, derris)

1. Indian subcontinent, Malaysia, China, Tropical Asia; to 8 m
2. Firewood, fodder (leaves), oil (seeds), pest control (leaves), shade tree, medicine
3. Mesic tropics (min. 600mm), saline tolerant; to full height in 5 yrs.
4. Aggressive spreading roots; also known as Derris indica (Lam.) Bennet

Prosopis alba/chilensis "Complex" (Chilean kiawe)
(Includes P. alba Griseb. and P. chilensis (Mol.) Stuntz; also P. flexuosa and P. nigra)

1. Argentina, Paraguay, Chile, S. Peru; to 15 m
2. Firewood, occasional use as timber; fodder (pods); to 12 m³/ha/yr
3. Cool dry subtropics (200 mm min); to 3000 m in Peru
4. Thorny but segregating 2n=28

Prosopis pallida/juliflora "Complex" (kiawe, algaroba, mesquite) (Includes P. pallida (Humb. & Bon. ex Willd.) and P. juliflora (Swartz) DC)

1. C. and No. S. America; to 15 m, aggressive
2. Firewood (.8 sp. gr.), exc. charcoal; fodder (pods), honey, wood, to 5 m³/ha/yr
3. Dry hot tropics, to 200 mm min; deep roots, some var. frost-tolerant
4. Thorny (segregating), often weedy (P. glandulosa and P. velutina are the mesquites of So. USA and elsewhere in tropics, often labelled juliflora in error) 2n=26,52,56

Pterocarpus indicus Willd. (Mimosaceae; Leguminosae)
(narra)

1. S. E. Asia, Indo-China, Pacific Islands; to 40 m, broad crown, lofty
2. Choice timber (narra), ornamental, furniture, flooring
3. Moist tropics; relatively fast growth
4. Needs deep soil; some diseases 2n=22

Robinia pseudoacacia L. (Papilionoideae; Leguminosae)
(black locust)

1. N.E. America, to 25 m
2. Fuelwood (dense), erosion control, nurse tree, posts, forage; to 20 m³/ha/yr;
3. Temperate, highland tropics
4. Winter deciduous 2n=20,22,24

Samanea saman (Jacq.) Merrill (Mimosoideae; Leguminosae)
(monkeypod, raintree, `ohai)

1. C. & So. America, Mexico; to 40 m, wide spreading
2. Shade, timber and craftwood, food (pod), sp. gr. .49, ornamental, fuelwood. (rare)
3. Mesic to wet tropics (to 600 mm min)
4. Defoliating insects common 2n=26

Sesbania grandiflora (L.) Poir. (Papilionoideae; Leguminosae)
(sesban, ohai-ke`oke`o)

1. India to SE Asia; to 10m, slender
 2. Pulpwood, forage (leaves, pods), food (flower, leaves, young pods), ornamental; sp. gr. .42; to 22 m³/ha/yr, large nodules
 3. Moist tropics (1000mm min), onto poor soils
 4. Genetic variability, soft wood, borer susceptibility
- 2n=14, 24

NFTA 82-04B

ECONOMICALLY IMPORTANT NITROGEN FIXING TREE SPECIES
"B" LIST

(James L. Brewbaker and Brian K. Styles, Eds.
Prepared for Bellagio NFT Workshop, Sept. 1982)

The following species were considered important economically, but of less importance than the annotated "A" list.

The first list includes species known to fix nitrogen, while those of the second list are not known to fix nitrogen

Acacia aneura F. v. Muell.

Acacia koa Gray (koa)

Acacia melanoxylon R. Br. (Australian blackwood)

Adenanthera pavonina L. (false wiliwili, red sandalwood,
hua`ula`ula)

Albizia prodera (Roxb.) Benth.

Alnus rubra Bong (red alder)

Dalbergia nigra (Vell.) Fr. All. (Brazilian rosewood)

Dalbergia latifolia Roxb. (Indian rosewood)

Enterolobium cyclocarpum (Jacq.) Griseb. (earpod, elephants ear)

Erythrina indica Lam (=E. variegata (L.) Merr.) (tigers claw,
Indian coral tree, wiliwili-haole)

Haematoxylon brasiletto Karst. (bloodwood tree)

Inga edulis Mart. (inga)

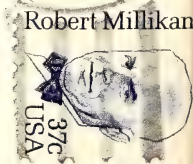
Inga paterna Harms (guama)

Sesbania bispinosa (Jacq.) W.F. Wight (= S. aculeata)
(rattlepod)

NEWSLETTER
HAWAIIAN BOTANICAL SOCIETY
c/o BOTANY DEPARTMENT
UNIVERSITY OF HAWAII AT MANOA
3190 MAILE WAY
HONOLULU HI 96822



Robert Millikan



3
H38

Hawaiian Botanical Society



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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

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ETIOLOGY OF RED LEAF DISEASE OF 'OHELO

Donald E. Gardner
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University of Hawaii at Manoa
Honolulu, HI 96822

For several years I have been aware of a very conspicuous reddening of leaves in the endemic Vaccinium species, particularly V. reticulatum and V. peleanum, in Hawaiian national parks and other native areas (Gardner 1980). One to several branches with reddened leaves may occur on an individual 'ohelo plant. These contrast sharply with normal surrounding green foliage. This condition has frequently attracted the attention of park visitors, as well as employees, who are sometimes told that the reddening represents the normal new growth of 'ohelo. While newly developing leaves of these Vaccinium species do exhibit reddening, coloration of new growth is not usually as brightly and uniformly red as are leaves of the abnormal condition.

In addition to red foliage, the diseased branches often have abnormal proliferation of twigs, forming a dense "witches'-broom". This, together with a thickening of branches of such "brooms", are indications that the disease is systemic. The symptoms are particularly visible to park visitors in the area of Haleakala National Park near Hosmer Grove, where 'ohelo comprises a major portion of the vegetation. Observations from a helicopter over more remote regions on the slopes of Haleakala where 'ohelo forms the dominant vegetation type have indicated the disease to be very common, with the red branches prominent and easily seen from a distance (E. Funk, pers. comm.).

Since affected twigs eventually lose their leaves and die, plants with older infections are typified by dead areas in which defoliated witches'-brooms are often clearly discernible. This further distinguishes the disease from normal new growth which is associated with vigorous development rather than dying tissue. Heavily infected bushes may be completely killed, but dead branches on otherwise healthy plants are more frequently observed.

Although I have recognized the existence of a pathological condition for some time, neither I nor Dr. John Kliejunas, a U. S. Forest Service plant pathologist who earlier investigated the disease in independent studies, had been able to detect obvious disease agents in initial observations. Both he and I suspected that a

mycoplasma may be responsible (see Gardner 1980). Mycoplasmas, which have properties similar to bacteria but are submicroscopic, are known to produce diseases in other plants with symptoms similar to those observed, including abnormal coloration and growth deformations. These diseases, which are important in commercial blueberry and cranberry (Vaccinium spp.) plantings on the mainland, have been diagnosed by direct observation of mycoplasma bodies in phloem cells of diseased tissue with an electron microscope. Electron microscopic examination of diseased leaf and petiole phloem tissue failed to reveal mycoplasma-like bodies in the Hawaiian material, however (unpublished results).

In recent critical reexamination of diseased leaf tissue, I have found the symptoms to be consistently associated with the fungus Exobasidium, probably E. vaccinii. The genus Exobasidium represents a small order of basidial fungi with obscure taxonomic relationships. Species of this pathogen typically occur primarily on Vaccinium and other members of the Ericaceae elsewhere, and are associated with deformities such as witches'-brooms or galls (Savile 1959). Reddening of foliage is a distinctive characteristic of Exobasidium infections. Basidia, usually with four large bean-shaped basidiospores borne on prominent sterigmata, are produced on the lower surfaces of infected leaves. The basidia occur individually and are not associated with any type of fruiting structure. The fungus may also produce conidia which are found among gray felt-like mycelial growth on the lower leaf surface. Extensive intercellular mycelial development is evident within the leaf tissue of prepared sections. The clear association of this fungus with symptoms typical of red leaf disease on Vaccinium species elsewhere leaves little doubt concerning the origin of the disease in Hawaii. Since morphological comparisons of the fungus itself with descriptions of E. vaccinii (Savile 1959) do not show significant variations, there is presently no basis to consider the newly discovered pathogen a new species.

This appears to be an example of a disease that may have been transferred from an introduced host to endemic Hawaiian plants, in this case, the Vaccinium species. The fungus has previously been reported in Hawaii on azaleas (Raabe 1966). Spores of the fungus are probably windborne (Hilborn and Hyland 1956), which may account for its spread to native plants. Studies conducted on the mainland with low-bush blueberries showed that E. vaccinii may spread systemically within infected plants into the rhizomes, where it is perennial. New plants developing from rhizome shoots may become infected from

this source (Hilborn and Hyland 1956). This means of local spread could possibly be operating in stands of Hawaiian Vaccinium, but I have no direct evidence for it at present. Inoculation studies on all native Hawaiian Vaccinium species should be conducted to determine host range, variations in susceptibility within and among species, and ease with which healthy plants may become infected.

Although I have previously suggested a possible relationship between the Vaccinium disease and the "yellows"-type disease of Dodonaea sp. in Hawaii (Gardner 1980; Gardner and Kageler 1984), I now believe these diseases to be unrelated, notwithstanding the similarities which do exist in the symptoms.

Acknowledgements

I appreciate the assistance of Dina Kageler and William Sakai with various phases of this study.

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HAWAII NATURAL AREA RESERVES SYSTEM

WITH GOVERNOR'S EXECUTIVE ORDERS (81,112 acres)

<u>Natural Area Reserve</u>	<u>Acres</u>	<u>Primary Feature</u>
<u>Hawai'i</u>		
Kipahoe	5,583	Mesic* forest, 'ohi'a and koa wet forests.
Laupahoehoe	7,894	'Ohi'a wet forest.
Manuka	25,550	Dry and mesic forests, 'ohi'a wet forest.
Mauna Kea Ice Age	3,894	Geological: Ice Age and Lake Waiau.
Pu'u Maka'ala	12,106	'Ohi'a and koa wet forests.
Waiakea 1942 Lava Flow	640	Recent lava flow with developing wet forest.
Wao Kele 'O Puna	16,844	'Ohi'a wet forest.
<u>Maui</u>		
Ahihi-Kinohi	1,238 (land) 807 (water)	Anchialine** pools, last lava flow on Maui, marine ecosystem.
<u>O'ahu</u>		
Kaena Point	12.464	Coastal dune ecosystem.
Mt. Ka'ala	1,100	Mesic and cloud forests, a montane bog.
Pahole	658	Dry and mesic forests.
<u>Kaua'i</u>		
Hono O Na Pali	3,150	Mesic forest, 'ohi'a wet forest.
Ku'ia	1,636	Dry and mesic forests.

*Mesic = moderate moisture.

**Anchialine = inland salt or brackish pools with no surface connection to the sea.

 APPROVED BY THE LAND BOARD (Executive Orders Pending)
Hawai'i

Pu'u O Umi	10,182	'Ohi'a wet forest, a montane bog, headwaters of six perennial streams.
------------	--------	--

Maui

West Maui		Pili grassland, mesic forest, 'ohi'a wet forests, cloud forests, montane bogs, headwaters and upper reaches of four perennial streams.
	(approx.)	
Kahakuloa Section	3,225	
Honokowai Section	625	
Pana'ewa Section	2,009	
Lihau Section	920	
Hanawi	5,500	'Ohi'a wet forest, cloud forest, alpine grassland.

A WORD ABOUT THE NEW OFFICERS

JANE E. LEWIS, President. Third-year Ph. D. student, working on marine algae (student of I. A. Abbott). Fluent in Mandarin Chinese, she lived in Taiwan for two years before coming to the University of Hawaii.

HEIDI BORNHORST, Vice President and Program Chairman. 1981 graduate in Horticulture, Heidi works for the Honolulu Zoo and before that had much experience with Hawaiian plants while working at Ho'omaluhia Regional Park.

CHRISTA RUSSELL, Secretary. 1982 M. S., University of Hawaii, Christa now works at the Bishop Museum in the Herbarium.

DERRAL HERBST, Treasurer. Ph. D., University of Hawaii working with Hawaiian euphorbs. Derral works for the Federal government and is responsible for listing and documenting endangered species of plants; he spends his spare time at the Bishop Museum helping with the revision of the Hawaiian vascular plants.

Minutes of the January 2, 1984 Meeting

The meeting was called to order at 7:30 p.m. by President Funk. Reports from the following committees were presented.

The Chairman of the Newsletter Committee, Dr. Isabella Abbott, asked for articles for future issues of the Newsletter. Dr. Abbott also reported that the editor of the Newsletter, Dr. C. W. Smith, hoped to have the next issue out by February, 1984.

Bill Brostoff, Science Fair Committee Chairman, would like volunteers to serve as judges for the annual Hawaiian Science and Engineering Fair.

President Funk reminded members that there will not be a regular February meeting. Instead, there will be a special joint meeting of the Hawaiian Audubon Society and the Hawaiian Botanical Society on January 30.

Ted Green showed Society members a flowering specimen of Angraecum sesquipedale (Orchidaceae).

The meeting was then turned over to vice-president Simon who introduced the special Nature Conservancy film "Garden of Eden". This film dealt with the subject of conserving gene pools of the world. Following the film Alan Holt, Nature Conservancy representative, gave a short talk about the Nature Conservancy in Hawai'i.

Vice-president Simon then introduced John Obata who gave a talk entitled "The Rarest Plants of O'ahu". John Obata has spent many years botanizing the hills and mountains of O'ahu.

Respectfully submitted,
Jane Lewis, Secretary

Minutes of the March 5, 1984 Meeting

President Funk called the meeting to order at 7:30 p.m. The January minutes were read and accepted and the treasurer's report is as follows:

Balance brought forward February 1, 1984.....	2,930.73
Receipts.....	112.69
Expenditures.....	437.88
Balance at the beginning of March.....	2,605.54

There was no membership committee report.

The conservation committee report brought up the problem of the environmental assessment for Unit IV of the Wai'ehu Heights Development, Wai'ehu, Maui. In this assessment permission was requested to bulldoze an area which is an important site for Scaevola coriacea, and in which other endemic plants are growing. It was suggested that a letter be written to the Maui County Planning Department pointing out the inadvisability of such action.

In new business, members were reminded of natural history programs at the Bishop Museum and films being shown at the Manoa Library.

The plant of the month speaker was Warren Wagner who spoke on the five Hawaiian species of Silene, and gave us an update on the Hawaiian vascular plant flora project.

The speaker of the month was Dr. Alan Templeton of Washington University, St. Louis, Missouri. He spoke on the genetic management of rare and endangered species.

March was also plant exchange month.

Respectfully submitted,
Jane Lewis, Secretary

Minutes of the April 1984 Meeting

President Funk called the meeting to order at 7:30 p.m. The March minutes were approved as read.

The treasurer reported a previous month's balance of \$2,605.54, receipts during the month of \$10.96, expenditures \$174.72, bringing the end balance to \$2,441.78.

Steve Montgomery, for the Conservation Committee, called for the membership to be aggressive in encouraging the state to hire three botanists with the \$55,000 allotted for that purpose. Otherwise the time for hiring will lapse. A motion was made and passed that The Botanical Society write a letter to the state, encouraging their action.

George Linney reported that the Native Plants Committee had bought supplies and was growing Brighamia, Pritchardia, Dodonaea and other native plants to prepare for the Friends of Foster Garden Fair.

The Newsletter Committee reported that the next Newsletter would be prepared within the month.

In new business, Oscar Kirsch had asked in October to be released from Marie Neal Fund responsibilities. The motion was made that Dan Palmer be selected to replace him, and it was passed by unanimous ballot.

The Plant of the Month speaker was Peter O'Connor, whose talk, "Indoor Plumbing in Plants" gave a colorful view of vascular tissue.

Dr. Douglas J. Futuyma, from the State University of New York system at Stony Brook, was the speaker of the month. He came as part of the Hawaiian Distinguished Speaker Program, and spoke on "Plants and Insects: What can we say about Coevolution?".

Respectfully submitted,
Jane Lewis, Secretary

Minutes of the June, 1984 Meeting

A field trip to Ho'omalahia Park, lead by Heide Bornhorst, was held in place of the regular June meeting. A car left from St. John Hall at 8:30 a.m., Saturday June 2, and met Heide and other Society members at the Park at 9:00 a.m.

Special areas of the Park which Heide explained were the camp areas with their different planting themes, and the native plant areas.

Respectfully submitted,
Jane Lewis, Secretary

Minutes of the October 1, 1984 Meeting

Pres. Funk called the meeting to order at 7:30 p.m.

Steve Montgomery, for the Conservation Committee, discussed the activities on Pu'u wa'awa'a Ranch, on the Big Island. Operated under a state lease, the land is being used for illegal harvesting of native forest. The membership voted in favor of Steve representing us in writing a letter of complaint to the State. We expect an update from him at the November meeting.

Pete Lowry, from the Missouri Botanical Garden was our Plant of the Month speaker, speaking and showing slides of his research on the Plants of New Caledonia.

The speech this month, by Dr. Charles Lamoureux and Ruth Gay, both of the Botany Department, U. H. was entitled "But it NEVER gets dark!". Accompanied by a rich assortment of slides, from mountain views from a 'plane to macrophotography of tiny forest ground inhabitants, our speakers shared their impressions of nature in northern Sweden at midsummer. Both had participated in an exchange program for biology educators geared toward familiarizing them with different ecosystems.

Respectfully submitted,
Jane Lewis, Secretary

Minutes of the November 5, 1984 Meeting

The meeting was called to order at 7:30 p.m. by Mrs. E. Funk, the Society president. Nominations for the 1985 officers were presented to the membership:

President:
Vice-President: Heidi Bornhorst
Secretary: Karla McDermid
(since withdrawn)
Treasurer: Derral Herbst
Directors: Bill Bush
Evangeline Funk

Wayne Gagne, for the Conservation Committee, presented the membership with his observations from visiting and investigating the illegal Koke'e koa logging operation. Gagne reported that after obtaining a permit to "salvage redwoods" on the roadway, the permit interpretation was broadened by the lessee from "redwoods" to "hardwoods", and under this permit the native koa forest is now being logged up to 66 feet back from the road. Their profit is substantial. They receive \$6-7 for one board foot, but pay only \$75/1000 board feet to the State as part of their permit agreement. A Conservation Committee meeting with State Park administration is being arranged.

A motion was made and seconded that in the event negotiations with park directors fail, the Society join with conservation organizations to seek legal remedy to stop logging and that we commit ourselves to a maximum \$200 which can go toward this end. After discussion, the motion was passed by the membership.

It was announced that the December meeting would follow the format of last year. After a short business meeting and address by President Funk, the members would

provide a program of shared slides, then recess to a social time of heavy pupus and plant exchange.

Bob Lee, from the State Department of Land and Natural Resources was our speaker. Talking on "The Natural Area Reserve Program", Dr. Lee outlined the present extent of the reserve program, a total of 81,112 acres on each of the four main Hawaiian islands. He explained the process of acquisition and management of reserves, and especially noted that the program encouraged scientific research within the reserves, an area of their program now being underutilized. Dr. Lee invited us all to consider this in our own research plans.

Respectfully submitted,
Jane Lewis, Secretary

Minutes of the December, 1984 Meeting

President Funk called the meeting to order at 7:45 p.m. The minutes of the November meeting were read and approved. The December balance in the Society treasury was \$2,344.48

In the absence of the membership chairman, Karen Asherman, Joan Canfield presented the Membership Committee annual report. For the year 1984, there were: 18 Honorary, 7 Life, 68 Regular, 19 Student, 15 Family, and, 7 Institution memberships, for a total of 134

Bill Brostoff, chairman of the Science Fair Committee discussed the results of the Science Fair this year. There were 70 botanical projects. Of note was a project on the blue-green alga Nostoc being used as a rice fertilizer. Bill suggested that prizes be upgraded for next year's fair.

Wayne Gagne, for the Conservation Committee, presented an update on the Koke'e logging operation on Kaua'i, and Pu'u wa'awa'a koa chipping operation on the Big Island to keep members aware of action to halt destruction of native forests. Action is being coordinated by the Environmental Council in Honolulu.

Elections were held for the 1985 Botanical Society officers. The results are:

President:	Jane Lewis
Vice-President:	Heidi Bornhorst
Secretary:	Krista Russell
Treasurer:	Derral Herbst
Directors:	Bill Bush, Evangeline Funk

In further new business, the Botanical Society was encouraged to seek private funding to allow the Society to be more able in implementing it's goals.

As her Presidential address, Evangeline Funk presented the Society with a slide tour of many of the sites where native Geranium species now grow in the Hawaiian Islands.

Respectfully submitted,
Jane Lewis, Secretary

GOODBYE TO THE "OLD DAYS"

With the death in December of Dr. Constance Hartt, plant physiologist with the HSPA for many years, and the more recent death (January 26, 1985) of Mrs. Annie Ho Coker, the people who knew Miss Marie C. Neal (author of "In Gardens of Hawaii", and former curator of the Bishop Museum Herbarium) best are now gone. Dr. Hartt shared a home with Miss Neal in Puunui, and also shared an interest in the Botanical Society. Miss Neal was partially deaf and did not participate in events where hearing was important. But for that impediment she probably would have served as an officer of the Society as Dr. Hartt did. The Marie C. Neal Fund, which pays for a number of Awards that the Society gives, is testimony of her interest in Hawaiian botany.

Mrs. Coker before her marriage, as well as after marriage, was the only assistant Miss Neal had, when the Herbarium was on the ground floor of Paki Hall. As Annie Ho, she had been hired as a janitress, and when Miss Neal needed help in pressing and mounting plants, Annie was trained to do these very important jobs, and worked part-time for Miss Neal for years. It was in this period that I was doing some independent research as a junior and senior with Dr. St. John and spent each Friday morning at the Museum on my research, and that afternoon helping Miss Neal with other curatorial jobs (filing, cataloging typing labels, etc.--the endless chores connected with herbarium work).

Isabella A. Abbott
Department of Botany, UHM

OBSERVATIONS ON SOME UNUSUAL FLOWERING CHARACTERISTICS
OF MYRICA FAYA

Donald E. Gardner
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Honolulu, HI 96822

Because of its importance as a pervasive alien plant in Hawaii, Myrica faya Ait. has received considerable attention directed principally at population characterization and control approaches in Hawaii Volcanoes National Park (HVNP) (Smathers and Gardner 1979; Gardner and Kageler 1982). I have also observed certain unusual features of M. faya of noteworthy botanical interest during these studies.

On initial observation, M. faya appears to be a dioecious species, with pistillate plants usually outnumbering staminate plants in HVNP study sites.* Anthesis and dehiscence of most staminate flowers, which occurs in the spring in HVNP, is marked by the release of clouds of pollen into the air and also by swarms of honey bees associated with staminate trees. Neither the mechanism for this selective attraction nor the role of bees in pollination (relative to wind pollination) is currently apparent to me; however, this association has been a reliable means of distinguishing staminate from pistillate trees from a distance.

Notwithstanding the strong tendency in M. faya toward dioecism, closer examination reveals a small number of pistillate flowers (usually noted by the more conspicuous fruits) on staminate plants and staminate flowers on pistillate plants. Since plant species are commonly categorized as either dioecious, monoecious, or hermaphrodite (with perfect flowers), M. faya represents a departure from the usual floral condition. Abbe (1974), in an extensive treatment of amentiferous plants, states that "Most species of the Myricaceae are dioecious, although individual plants of some species have been reported to reverse sex in succeeding years, or to have some branches which are male and others which are female." Lloyd (1981) reported M. gale L. to be a subdioecious species and suggested that this floral condition had resulted by evolution from monoecious

*Observations by C. S. Hodges and myself in the native habitats of M. faya (the Azores, Madeira, and the Canary Islands) indicate that sex ratios may vary, with staminate plants frequently predominant at particular sites.

ancestors. At Lloyd's observation sites in Wales, staminate stems of M. gale greatly outnumbered pistillate stems.

Although M. faya itself has received little direct research attention from a botanical standpoint, the apparent subdioecy condition in this species may be comparable to that in M. gale. Few detailed studies have been conducted on evolutionary intermediates between monoecy and dioecy, and, as stated by Lloyd (1981): "There is a need for further observations on populations with separate male and female sexes which have evolved from monoecious ancestors." Lloyd (1981) discussed in some depth the potential of environmental and developmental influences in determining sex of M. gale stems, branches, or inflorescences. Such "plasticity" with regard to floral development appears to be characteristic of the Myricaceae in general. I have observed no evidence, however, that sex reversals in individual plants or branches of M. faya occur over periods of time as Lloyd (1981) suggested for M. gale.

A further unusual and noteworthy characteristic is the occurrence of stamens on fruit surfaces of pistillate M. faya trees. Fruits of Myricaceae are classified as small drupes (Neal 1965) or small wax encrusted nuts (Macdonald 1980). The fruit is covered with emergences (Abbe 1974), which in M. faya are succulent and edible.* Stamens borne on the fruit surface appear conspicuously out of place. They occur individually or in small clusters and are apparently sessile, but actually are produced on short stalks arising from between fruit surface emergences.

Although this uncommon placement of stamens has not been directly investigated in M. faya, Macdonald (1979) has conducted serial developmental observations of a similar phenomenon in a closely related species, M. californica Cham. & Schlecht. Both M. faya and M. californica, as well as certain other Myrica species, are reported to possess a gynecandrous inflorescence (having both pistillate and staminate flowers) (A. D. Macdonald 1979; personal correspondence). During fruit development, the axis of the inflorescence itself becomes modified as a consequence of differential growth and

*M. faya fruit is consumed by pigs and by certain birds, which probably serve as major dispersal agents in HVNP. In the native countries of M. faya, the fruit is reportedly used for wine-making.

forms a portion of the fruit wall.* Primordia, which typically produce either wax-secreting papillae or stigmas may occasionally produce a stamen instead, further illustrating the plasticity of floral development in this group (A. D. Macdonald, personal correspondence). Stamens formed in this manner eventually become positioned on the fruit surface as a result of expansion of inflorescence tissue destined to become part of the fruit wall.

My observations indicate that stamens formed on fruit surfaces appear morphologically identical to those produced in aments (termed catkins by other authors) on staminate plants. Furthermore, I have observed such stamens to contain apparently functional pollen and to dehisce in a normal manner. This is in contrast to the obviously nonfunctional stamens and carpels produced in unusual positions on plants of M. gale (Lloyd 1981).

Members of the Myricaceae continue to present challenging subjects for plant morphological, developmental, and phylogenetic studies (cf. Abbe 1974; Lloyd 1981; Macdonald 1977; 1979; 1980). My observations suggest that a similarly detailed investigation of M. faya would likewise yield interesting and botanically significant information.

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*A fruit formed in this manner from tissue other than the ripened ovary wall would appear to meet the definition of an accessory fruit, although I have not seen this term used in literature discussions of Myrica spp.

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MEMBERSHIP

Membership dues for each calendar year are as follows:

Student	\$4.00
Regular	\$7.50
Family	\$10.00
Life (for individuals only)	\$100.00

Send cheque or money order to Karen Asherman, Department of Botany, University of Hawaii, 3190 Maile Way, HONOLULU HI 96822.

Membership renewal should be made as soon as possible at the beginning of each calendar year. A notice will be circulated in the near future asking members in arrears to bring their membership up-to-date.

RANGE EXTENSION OF DIAPORTHIOPSIS METROSIDERI
TO BIRD PARK,
HAWAII VOLCANOES NATIONAL PARK

F. R. Fosberg
Botany Department,
National Museum of Natural History,
Smithsonian Institution
Washington, D. C.

In a recent issue of this Newsletter (22:13-16, 1983) I summarized what is known of the ecology, pathology, and distribution of Diaporthiopsis metrosideri Roane and Fosberg (Endothia metrosideri (R. & F.) Barre), distributed roughly from Kipuka Nene to Kilauea Iki and Volcano Village.

Because of its apparent pathogenicity to the most important Hawaiian tree species, it seems of interest to report even small extensions of its range. On March 26, 1984, I investigated a small area of open Metrosideros forest just outside the entrance to Kipuka Puaulu (Bird Park), Hawaii Volcanoes National Park, that showed a number of dead trees and others that seemed in poor condition. Four recently dead trees exhibited the characteristic lumpy black fruiting bodies of Diaporthiopsis metrosideri, pushing out of cracks in the bark (Fosberg 64306 (BPI,BISH)).

In view of the ecological importance of its host tree it seems urgent to undertake an intensive effort to determine the full geographic range of the fungus, whether or not it is spreading, the mechanism of its dispersal and establishment, details of infection, and the precise degree of its parasitism. This would seem to be a task for an experienced forest pathologist, and to merit serious attention from the research authorities of the National Park Service, as well as from the Hawaii State Forester. This infestation may already be on the way to becoming a major problem in the moist and semi-dry 'ohi'a-lehua forests of Hawai'i.

I wish to thank the Pacific Tropical Botanical Garden for making it possible to visit Hawaii and to continue observation of this fungus.

Minutes of the January, 1985 Meeting

The new President, Ms. J. Lewis, called the meeting to order at 7:40 p.m. The minutes of the December meeting were read and approved. The balance in the Society treasury, as of January 1, 1985, was \$2,458.11.

There were no Committee reports.

Constance Hart, formerly with HSPA, co-founder of the C4 pathway, and longtime member of the Society passed away in December, 1984. She was a close friend of Marie Neal and a trustee for the Marie Neal fund. During the meeting Dr. Derral Herbst was nominated to take Ms. Hart's place as trustee. This proposal was endorsed unanimously by the members present.

The Botanical Society was encouraged to investigate claims that the Police Department is proposing to use an oil base spray, aerially, on "pakalolo" without evaluating the consequences in an Environmental Impact Statement. The matter was referred to the Conservation Committee chairman.

Mrs. Evangeline Funk, our recent President, showed slides of Piper methysticum ('awa) and briefly explained some ethnobotanical uses of this Polynesian introduction.

Ed Eby, outgoing president of the Cactus & Succulent Society, presented an interesting and informative talk on some of the cacti and succulents which he raises in Waianae, as well as some humorous anecdotes of his collecting experiences.

A plea was made once again for the members to provide information for the Newsletter. Observations on recent escapes, range extensions of weeds, concerns about environmental issues, checklists of plants from infrequently visited areas, anecdotes on members, even horticultural notes are welcome. A Newsletter cannot function without the participation of the membership. A paragraph or two is all that is needed and we have a number of volunteer editors who will help you. Please do not hesitate to send information in; what may seem humdrum to you may be of interest to other members.

Respectfully submitted,
Christa Russell

HAWAIIAN BOTANICAL SOCIETY,
C/O DEPARTMENT OF BOTANY
UNIVERSITY OF HAWAII,
3190 MAILE WAY
HONOLULU HI 96822

PRINTED MATTER

Hawaiian Botanical Society



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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

NEW OFFICERS OF THE HAWAIIAN BOTANICAL SOCIETY 1985

Executive Council

President:	Jane E. Lewis, University of Hawaii
Vice-President:	Heidi Bornhorst, Honolulu Zoo
Treasurer:	Derral Herbst, U.S. Fish and Wildlife Service
Secretary:	Christa Russell, Bishop Museum
Directors:	Evangeline Funk, University of Hawaii Bill Bush, Retired Isabella Abbott, University of Hawaii

Committees (appointed by the Executive Council)

Membership:	Karen Asherman, Chair
Newsletter:	Isabella Abbott, Chair Clifford Smith, Editor
Conservation:	Elizabeth Powell, Chair Lani Stemmermann, Hawai'i Art Medeiros, Maui
Science Fair:	William Brostoff, Chair Alvin Yoshinaga
Native Plants:	Clifford Smith, Chair Carolyn Corn, Ken Nagata Evangeline Funk John Obata Lani Stemmermann, Hawai'i Art Medeiros, Maui
Publicity:	Marilyn Cannon, Chair

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Minutes of the February, 1985 Meeting

President Lewis called the meeting to order at 7:30 p.m. The minutes of the January meeting were read and approved.

Derral Herbst presented the Treasurer's report as follows:

Balance as of Jan. 1	\$2,458.11
Receipts	17.50
Expenditures	16.60
Interest	10.79
Balance as of Feb. 1	\$2,469.80

An audit of The Botanical Society's financial accounts showed them to be correct.

There were no Committee reports.

President Lewis announced the formation of a Publicity Committee. The function of this committee is to notify members about meetings, to provide information about the Society to the local media, and to organize the mailing of the Newsletter. The chairperson of this committee is Marilyn Cannon. At present there is no other person on the committee.

A resolution to move the Marie Neal Trust Fund to a savings account at First Federal Savings and Loan Association of America was proposed by Charles Lamoureux, and adopted by the Society.

Bill Brostoff proposed that the Society give \$100 in cash awards to winners in the Science Fair this year. After some discussion \$200 in cash awards was approved for this year's winners, and the Science Fair Committee was encouraged to give several small awards rather than a few large awards.

Plant of the Month Speaker, Sandi Baniaga of Hawaiian Sugar Planters Association, Department of Pathology, spoke on old Hawaiian varieties of sugarcane. The Hawaiians had names for at least 40 varieties of sugar cane, though few, if any, are cultivated today. The Hawaiians had many uses for sugarcane other than as food, such as for aphrodisiacs.

Dr. Mark Littler, Chairman of the Botany Department at the Smithsonian Institution, Washington, D.C. was Speaker of the Month. Dr. Littler showed slides taken from a deep-sea submersible off San Salvador Island in the Bahamas. Dr. Littler found a species of algae

growing at a depth of 880 feet, a new record for plant life. The slide sequence showed the different marine life zones from the bottom of a seamount off San Salvador Island to the top of the seamount, which was about 200 feet below the surface of the ocean.

Respectfully submitted,
Christa Russell, Secretary

RESOURCE USE CONFLICT IN HAWAII

A resolution endorsed by the 5th Pacific Science Association Inter-Congress held in Manila, Philippines, February 3-7, 1985.

WHEREAS, the search for alternate energy resources in the State of Hawaii has led to the use of sugarcane bagasse as a fuel for generating electricity; and

WHEREAS, with the cessation of sugarcane production in some parts of Hawaii for economic reasons, a shortage of sugarcane bagasse has recently led to the logging and woodchipping for electricity generation of the last remnant of virgin tropical lowland rainforest of Hawaii; and

WHEREAS, upon being informed of the scientific, educational, and cultural resource values of such native biota and ecological systems, the Hawaiian business community began to take measures to leave the native forest alone and turn its attention to less controversial bioenergy resources, such as non-native eucalypt trees originally planted for commercial purposes;

BE IT RESOLVED, that this meeting of the Pacific Science Association urges that publicity be given to resource use conflicts of this kind, so informed scientific opinion can be brought to bear in an effort to find means of combining natural energy resource development with good conservation practices; and

BE IT FURTHER RESOLVED, that the Pacific Science Association, through its Scientific Committee on Ecology, Conservation and Environmental Protection, monitor the progress of the important resource use issue in Hawaii, since it provides a potential model for resource development in the Pacific Basin whereby such development is carried out with due respect for environmental values and concerns.

ANOTHER NOXIOUS MELASTOME?
OXYSPORA PANICULATA

John K. Obata
1337 Ala Aolani
Honolulu, HI 96819

Oxyspora paniculata (D. Don) DC. is a melastome with very showy, large lavender-pink panicles. It is a large shrub and may attain a height of over 3 meters (10 ft.). It may have been cultivated on O'ahu in the past and is now naturalized. Very little is known of this magnificent species.

The Bernice P. Bishop Museum has the following vouchers. The first specimen collected was deposited by G. Pearsall from the "Manoa Ridge trail" on October 10, 1958. Subsequently another collection was made by him on the Manoa Cliff trail (Tantalus) on August 20, 1959 from a "12 feet high" bush. Pearsall's final collection was from "Tantalus" on October 8, 1959. The last voucher on record was that of W. Gagne and J. Obata from the crest slightly east of Pu'u Konahuanui. One mature shrub was noticed at that time (October 13, 1974). A few more plants were noticed west of Pu'u Konahuanui in the years to follow. None exhibited any signs of regeneration. Pearsall had previously commented "this plant does not spread, doesn't seem to be a pest." In 1967, a plant was found in the Aihuanu section of the Lyon Arboretum (pers. comm. R. Hirano). A few plants have been observed since. After observing the few plants along the Pu'u Konahuanui summit area for the past ten years, this writer was convinced, as Pearsall was, that this species was non-proliferating. Then on November 11, 1984, all previous evaluations of Oxyspora paniculata changed.

On this date a large regenerating population of Oxyspora was seen along the upper reaches of Lulumahu Stream which radiates from Pu'u Konahuanui. Many mature plants were noted along the stream banks with countless seedlings. The infested area on a casual observation was at least 0.8 km (0.5 miles) long, but no attempt was made to determine its exact range.

Oxyspora seemed to be the dominant plant along the upper Lulumahu Stream banks. They seem to be displacing other smaller flora, even Clidemia hirta (Koster's Curse), another noxious Melastome. So far few plants have penetrated beyond the river bank habitat but they appear to be capable of doing so.

On subsequent trips along the Ko'olau summit from Pu'u Konahuanui to Niu Valley, the spread of Oxyspora was further observed. Many, adult, reproducing plants were firmly established along the summit's leeward face of Manoa Valley. They were also established beyond Mt. Olympus along Palolo Valley's leeward crest. As visibility was poor on both trips, its vertical spread could not be observed. Judging from the maturity of the plants observed along the summit area, one might assume the spread of these plants into the gullies below as duplicating the Lulumahu infestation.

The implication of this infestation may have some far reaching consequences. Is Oxyspora paniculata another in the growing list of noxious weeds taking over part of our wetter native forest? Based on the population explosion observation of November, 1984, the possibility is very real. Is this another Clidemia type of infestation? The field observations seem to support this contention. Could physical extermination (pulling) be a potential technique to eradicate this species? At this stage, perhaps, but we will have to move quickly.

MEMBERSHIP SURVEY

There's still time to send in the membership questionnaires inserted in the last newsletter. Responses will be tallied, suggestions noted and a report written for the following issue of the Newsletter, along with a current membership list. Thanks to those who have responded so far!

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Send cheque or money order to Karen Asherman,
Department of Botany, University of Hawaii, 3190 Maile
Way, HONOLULU HI 96822.

HONOLULU BOTANIC GARDEN'S
HISTORY, PHYSICAL SET UP AND GOALS

Paul R. Weissich
Director
Honolulu Botanic Garden
50 North Vineyard Blvd.
Honolulu, HI 96817

Honolulu in 1850 was an exciting and promising place for the adventurous and the farsighted. The discovery of gold in California created an immediate demand for food and materials needed by the hordes of miners scrambling to the gold fields.

Honolulu was weeks closer to San Francisco than the east Coast supply centers thousands of stormy miles distant around Cape Horn. At the same time transpacific shipping was increasing as markets opened to the West throughout the Orient. Honolulu was the logical stopover after the long trip around the Horn or homeward bound from the far reaches of Asian ports.

The demand for repair facilities, food, drink and construction materials was far beyond the immediate supply capabilities of the Kingdom of Hawai'i. To meet these opportunities, King Kamehameha III, supported by Honolulu businessmen, created the Royal Agricultural Society, whose charge was to study the development of suitable food crops for the gold rush trade and to import promising tropical timber trees appropriate to the needs of the new ship servicing and repair facilities then under construction on the crowded harbor front.

Kamehameha III had created a botanical garden devoted to the growing and testing of these new materials. But financial needs forced the King to sell off lots in the area and a new experimental garden was planned nearby adjacent to the well-developed garden of Spanish immigrant, Don Francisco de Paula Marin, who in the early 1800's had already introduced a number of fruit trees, including guava, citrus, avocado and grapes from Mexico. His vineyard as early as 1817 provided wine and brandy for the King's table.

Unfortunately the King's plan for a new experimental garden was never realized.

Next to Mr. Marin's garden was a 4-acre plot of land served by two streams and conveniently close to the center of the city as well as neighboring areas of

horticultural interest. It was ideal for newly arrived 29-year-old German physician, Dr. William Hillebrand, who was able to purchase it from Queen Kalama in 1850. The doctor quickly established himself, becoming physician to the Royal family.

During this same period, caught up in the exciting economic developments of the Kingdom and being close to the King, Hillebrand availed himself of the generosity of visiting sea captains to assist him with the importation of trees and interesting plants from the tropics which he planted on his new property. His garden inventory of 1854 lists 160 species of plants among which were trees of potential importance to the Kingdom's economy.

Dr. Hillebrand's importations continued for 20 years. Upon his return to Germany, the Foster family purchased the property, and expanded the grounds and the collection.

Shortly after the turn of the century the sugar industry, now a half century old, thriving and prosperous, became aware of the need for watershed conservation, the guarantee of a constant source of water for the ever-thirsty sugar fields. Toward this end the sugar planters began an energetic, ambitious and highly successful program of tropical plant introduction. A nursery was established between the Foster's garden and Marin's garden. Within four decades over 10,000 species of tropical trees, shrubs and vines had been funnelled through the nursery and into a series of experimental arboreta throughout the Territory located in a wide variety of climates, wet, dry, hot, cold.

On the Island of Hawai'i alone 22 arboreta were established on 70,000 acres of land. These are now great stands of trees. This was the beginning of the modern "alternate site" development in Hawai'i. Its impetus was commercial, not scientific, as had been that of the 1850's and the success of the venture depended entirely on a horticultural understanding of the alternate site concept as uniquely applicable to Hawai'i.

First-time visitors to Hawai'i, at least those who are aware of more than the more basic attractions of Waikiki beach, are astounded at the rapid changes in climate within amazingly short distances. Waikiki is a desert with an average of 17 inches of rain per annum. Fifteen automobile minutes away, one reaches the end of Manoa Valley with an annual average of 160 inches of rain. Temperatures at the end of this 500 feet elevational climb are normally several degrees lower than

along the coast with humidities almost doubled. Even greater variations occur on the Island of Hawai'i where 14,000 foot Mauna Kea attracts skiers part of the year and boasts a mountain-top pond whose depths have not thawed for centuries. A drive of an hour in one direction takes one to Hilo at sea level, a center for the commercial production of hybrid Anthurium and orchids, both suited to its high humidity and 120 inches of rain, while a shorter drive in the opposite direction meanders through "California climate" cattle ranches and finally delivers one to the hot, dry Kona Coast, a thriving tourist mecca similar to Waikiki. Yet in a 10-minute drive up the steep mountain slope directly behind Kona, one enters the cool, moist band in which the famous Kona coffee industry is rooted. It is obvious that climate in a mid-ocean tropical island varies rapidly with elevation, exposure to prevailing trade-winds and location within the "rain shadow" of a high mountain. It should be equally obvious that the opportunities for developing alternate sites in Hawai'i based on botanical/horticultural diversity are almost limitless.

The famous David Fairchild, returning from an Asian voyage stopped off in Honolulu about 1897. Viewing the valleys behind the harbor, he realized the immense horticultural and botanical advantages of establishing an "alternate site" garden in Hawai'i and recommended the establishment of such a garden running from sea level to the top of the main Oahu mountain range some 3,000 feet in elevation. Unfortunately, this recommendation to develop a botanic garden was not pursued for reasons unknown. It was not until 1950 that the first multiple site or alternate sites system was formally initiated by Dr. Harold Lyon, Director since the 1930's of Foster Garden (which was given by Mary Foster to the City of Honolulu upon her death) and for years leader of the Sugar Planter's plant introduction program.

Actually the concept has been in operation in Hawai'i for a thousand years. The early Polynesian settlers came from high islands. They knew that higher elevations are cooler and the tradewinds side of the island wetter, leeward side dry. Their entire system of land management was based on the 'ahupua'a, a strip of land running from the sea to the mountain top providing all the products of the ocean, especially the fish, and edible seaweeds, and the coconuts, breadfruit, taro and sweet potatoes of the hot coastal plain and lower valleys where water was plentiful from streams and springs. The forest furnished some medicinal herbs, canoe building

timber, fine fibers and brilliant feathers for the great ali'i cloaks and helmets.

A discussion in contemporary terms will serve to illustrate Hawai'i's current "alternate site" concept and explain the development of such sites within a public system such as Honolulu Botanic Gardens.

Since 1930 the original nine-acre Foster Garden bequest has grown through the efforts of the City and County of Honolulu to a multiple-site garden system encompassing 800 acres on five environmentally differing sites with two more in the early planning stages. Much of the acreage is understandably still undeveloped.

Foster Garden, now a fully developed 20-acre site, lies along the coastal plain in downtown Honolulu. This area enjoys year-round high temperatures. Rainfall averages 30 inches per year. Our old trees date from the 1850's and are representative of the King's efforts at economic growth. Twenty-five minutes to the east along a modern coastal freeway is our Koko Crater Botanic Garden, 200 acres, in early stages of development. The crater is, hopefully, permanently inactive, the last eruption dated some 30,000 years ago. The crater's climate is hot, and very dry with an average of only 17 inches of rain a year. There are years with less than an inch. We have planted out a thousand species of dryland tropicals from East Africa, Socotra, India and the New World. Driving along the freeway 25 minutes to the west of Foster Garden is our Wahiawa Botanic Garden, once one of the Sugar Planter's experimental arboretum, located in the cool 1,000 foot high plateau between Oahu's two main mountain ranges.

Wahiawa averages ten degrees cooler than the coast with rainfall at 80 inches per year with a remarkably even distribution and high humidity. Planted out here are the tropicals thriving in that environment, the New Caledonian conifers and palms, tree ferns, Aroids, trees and shrubs from the Central American mountains and epiphytes from everywhere. To the north of Foster Garden a 15 minute drive on the trans-Koolau freeway brings one to the windward coast where we have just opened a 400-acre area with 100 inches of rain per year, Ho'omaluhia. Crews have just completed the planting of our 6,000th specimen representing nearly 3,000 species. Here, arranged in geographical/environmental sections, are the wet, warm-loving materials from the world's disappearing tropical lowland floras, Malaysian, tropical African, Melanesian and so forth. A special effort is toward a significant collection of native Hawaiian

materials. There are two other sites under preliminary planning, a several hundred acre fresh-water swamp, again 15 minutes from downtown Honolulu, and a 200-acre brackish water swamp a few minutes farther along the coast. These will provide obvious alternate sites for the growing of those plants adapted to fresh and salt/brackish water areas. Their development is "down the road" but still part of a long-term plan.

Honolulu Botanic Gardens developed the "alternate site" system of gardens for two reasons: (1) our unique climatic/topographical situation makes it possible to grow an amazing array of tropical plants on sites quickly reached by freeways, and (2) the sites are developed as passive recreation/education areas conveniently accessible to island residents and visitors. We, therefore, are able to develop collections of significance insofar as their value to science is concerned while at the same time adding to the public's easy use of those sites as places of recreation and education. Collections are for the greatest part from wild collected materials or from those whose original sources are known from the wild. A careful accession system is maintained based on that designed for us by a consultant from the University of California Botanic Garden. All plantings are mapped. An annual inventory update is maintained. A complete onsite inventory of all collections is made each ten years. Our inventory and accessioning is not yet computerized.

What are some of the problems inherent in managing such scattered sites? First, of course, there is a built-in degree of inefficiency due to the physical separation of sites. Each site must have its own maintenance crew totalling more staff than if work were being performed on one large site. Delivery of materials and supplies is time-consuming and costly. The management of personnel, the settling of grievances, staff meetings are all less efficiently handled by management and thereby more costly. Communications are less effective or at least more difficult to handle as effectively than on a one-site garden. These are the obvious drawbacks. I cannot furnish statistics based on a cost analysis. There are no comparative or parallel costs available locally and mainland analyses would not pertain to our unique island situation and the City's current operation at least through the Department of Parks and Recreation, renders any full accounting impossible until completion of our new computerized accounting system. This area will be explored under budgetary considerations.

The question is: is it worth it? In terms of public service, availability of passive educational recreation to the general public the City so far has responded affirmatively. What modifications? Tight money, no Federal money and inflation will force on the City's perspective is yet to develop. Certainly we are feeling the pinch as have all government agencies and every American family.

Programs are offered on three sites: Foster and Wahiawa Botanic Gardens and Ho'omaluhia. Our clientele is the layperson, the man-in-the-street. We do not consider ourselves a scientific research institution although our well-documented collection numbering close to 10,000 species has been well used by researchers and teachers.

At Foster Garden scheduled free guided tours are available three times per week in addition to "on demand" tours for adult and school groups. Last year volunteers conducted 248 of these tours. Foster Garden distributes to visitors, free of charge, a simple self-guided tour booklet: 13,954 of these were used in 1981, and an additional 1,617 Japanese language brochures were given to our many visitors from Japan. There are also five free brochures on special plant groups within the garden, Cycads, Heliconicas, and others.

The structured program is offered on a trimester basis with classes, lectures and hikes. Registration is usually filled and with waiting lists for some, especially the outer island Hawaiian trips which have become very popular. We feel we are building a strong base in the lay public for the appreciation and support of conservation, for scientific study and a realization of the urgency for action toward the saving of the exceedingly fragile Hawaiian ecology. The Fall trimester registered 341 participants in programs involving 3,921 instruction hours. One full-time Educational Coordinator and a part-time assistant run this program.

The Wahiawa Garden offers guided tours to school and other groups and a free self-guided tour brochure.

The Ho'omaluhia program concentrates on ethnobotany and environmental concerns. The plant collection is distributed throughout the 400-acre site as previously described. The collection will eventually form the basis for the program. In the mean-time, while the young trees grow into more appreciable sizes, our program emphasizes the unique topography of the site which lies at the foot of a 1,500 foot cliff, its hydrological resources, highly

variable micro-climates, birds, native plants and its place in the history of Hawai'i. Programs designed to extend for more than one day will also offer the opportunity to camp out in the midst of the collection. Only those who register for program may camp. All use of the garden is strictly controlled by special rules and regulations recently formalized by the City. Program campers as well as day-users enjoy 24 hr/day security. The garden is locked at night. Ho'omaluhia's program is experimental and may well become a prototype for similar natural areas on 'O'ahu.

Another program based at Foster Garden but involving 13 sites scattered from one end of 'O'ahu to the other is our Community Recreational Gardening Program currently involving over 2,500 dirty but happy vegetable, herb and flower gardeners. The City provides free land and free water. Each garden is required to organize itself a cooperative group with officers, regular meetings and a promise to abide by the rules and regulations originally drawn up by the gardeners themselves which restrict gardeners only in that illegal plants are banned. The gardens are a fascinating collection of vegetables, exotic and common herbs, species and flowers. Discipline is dispensed by elected members of the garden. Each garden sends two representatives to a monthly Garden Council meeting at Foster Garden. Common problems, educational programs, recipes, literature, composting secrets and general information are shared. This out-reach program provides many apartment dwellers an opportunity for a kind of recreation unavailable in any other program. Seniors have discovered the program is a means of making new friends and re-establishing contact with persons of all ages. It should be noted that the median age group is about 35 years of age, the youngest five years and the oldest 85 years old. Most gardeners fall into the 30-40 age group. We have found it necessary to translate all garden materials into eight languages to accommodate the many recent immigrants from southeastern Asia and southern Polynesia. Community Gardening has been an important learning experience in American democracy, a means of gaining facility in the English language and a quick way to make local friends.

The last of our programs is, I believe, unique to Hawai'i. This is Exceptional Trees Program, mandated by the State Legislature in 1975. Each County in the State is required to search out, identify and protect by ordinance its most unusual trees. Qualifications for this honor include age, rarity and historical significance. Last year the 'O'ahu tree committee added its 105th tree to the protected list. This program is

administered through Honolulu Botanic Gardens with montly meetings held at Foster Garden.

Staffing for our various areas and programs is small. Organization is simple; the budget, even with today's dollars, is adequate and provides for modest luxuries (e.g. brochures are still given out free of charge).

Honolulu Botanic Gardens is organized as a Division of the Department of Parks and Recreation of the City and County of Honolulu, a community of over 800,000 representing about 90% of the State's total population. The City and County of Honolulu comprises the entire Island of 'O'ahu.

Each garden has a supervisor. Five of the smaller gardens are organized under a horticulturist. The sixth garden, Ho'omaluhia, has its own horticulturist. Both horticulturists report to and work with the Director. Program staff at the Ho'omaluhia garden also reports to the Director, who coordinates grounds and program activities at Ho'omaluhia. All told the Botanic Gardens Division has a staff of 33 full-time employees and 16 part-time employees distributed through the system. It must be kept in mind that the system is not yet fully developed, several sites are still in very early phases of development. Additional staff will be added over the years as required and finances permit.

To date the City has been generous. Since the formalization of the Division in 1960 the City has expanded the gardens from 50 acres to 800 acres and the staff from 5 to the present level. Our annual budget for the fiscal year 1982-83 provides \$476,000 for salaries, \$237,000 for daily operating expenses, utilities and supplies and \$11,000 for new equipment for a total of \$724,000. This does not reflect, however, the total cost of operating our system. The City and the Parks Department provides numerous services not charged against the gardens' budget, expensive items including all structural maintenance and repairs, all vehicle repair and operating costs, all heavy equipment needs, carpentry for display and exhibits, all fiscal services, personnel services, architectural and engineering services and program assistance through specialists in other divisions. I have no way of assigning dollar values to these items. It is obvious, however, that the administration of a system of gardens such as ours is greatly simplified and convenienceed and its budget significantly augmented by its attachment to a large City structure.

It is equally obvious that we could not manage the areas and programs described above without some form of additional staffing. That support comes from a legion of volunteers without whom we could not carry out any but the simplest tasks.

Main volunteer support comes from the Friends of Foaster Garden, an incorporated citizen support group established in 1960. The Friends finance the Foster Garden Education Program, paying the salary of the Education Coordinator and one part-time helper. Volunteers are enlisted for special education activities. The City furnishes space and utilities and staff back-up. Our self-guided tour brochures were done by volunteers; volunteers conduct all guided tours, augment the nursery staff, purchase books for our library, pay for staff training programs, assist with grounds cleanup, mow lawns and organize two plant sales a year which furnish the bulk of Friends' operating dollars.

Our Plant Import Program is almost totally funded by the Friends. Over the last ten years this has seen well over 10,000 accessions. Our small reception office at Foster Garden is manned 363 days of the year by volunteers from the Outdoor Circle, a women's organization started in 1916 to promote the planting of street trees and in parks and school yards. The Circle, incidentally, is responsible for the billboard law. (You see no billboards lining Hawai'i's highways.) The Outdoor Circle has published a quality book with text and photographs covering the Exceptional Trees of 'O'ahu. The Outdoor Circle provides the volunteers for our school tour program.

The Community Gardening Program is staffed by one half-time person, the obvious slack being covered by the Garden Council and volunteers from each garden. This system has worked well; not perfectly, but well. The Exceptional Trees Program is similarly handled by a part-timer with the volunteer committee itself handling all field-work and reporting.

All volunteer groups are coordinated by the Director who must make sure volunteer efforts and staff efforts are operating on the same frequency and not at odds. Harmony is usually the case. As any agency utilizing volunteers knows, volunteers are not always the happiest solution as replacement for regular staff. We have found, however, that volunteer enthusiasm and open-mindedness have infected staff with a perspective assuring us of our ability to tackle anything with

success. Honolulu Botanic Gardens is oriented to lay people. Our volunteers keep us on track, pick us up when we crash and push us ahead when we falter. They are a healthy and necessary part of our organization.

An alternate site garden system does have inherent problems. But it also presents a series of great opportunities for developing attractive educational and recreation resources for the community as well as important scientific bases for the growing, studying and preservation of the world's flora. In Hawai'i, botanical values are accentuated by the emergency need to save much of the tropical world's rapidly disappearing flora. Our gardens in conjunction with others in the State including the Pacific Tropical Botanical Garden, the Waimea Arboretum and the Lyon Arboretum of the University of Hawaii form a cooperative complex of tremendous potential and value to the future of man's knowledge of the flora of the tropics. Honolulu Botanic Gardens' contribution to the public awareness of the need for conservation as well as its role in actual preservation through collections constitute our role and commitment.

Minutes of the March, 1985 meeting

President Lewis called the meeting to order at 7:30 p.m. The minutes of the February meeting were read and approved. The March balance in the Society treasury was \$2480.81.

Marie Brugemann, for the Membership Committee, announced that dues notices will be in the next Newsletter. Dr. Abbott announced that the Botanical Society Newsletter was at the printer and would be mailed to members within 2-3 weeks.

Plant of the Month Speaker, Leland Miyano introduced Society members to the number of species of cycads which he raises as a hobby.

Dr. Roy Nishimoto, Chairman, Department of Horticulture, University of Hawaii at Manoa, gave an overview of recent developments in the control of weeds. According to Dr. Nishimoto, herbicide-oriented research is the basis of modern weed control. Other methods include the use of machinery, manpower, allelopathy, soil solarization, mulching, and the use of biological control agents.

Respectfully submitted,
Christa Russell, Secretary

HAWAIIAN BOTANICAL SOCIETY AT THE SCIENCE FAIR

Each year, nearly 70 junior and senior high school students entered in the Hawaiian Science and Engineering Fair compete in the area of Botany. The science fair is an opportunity for these students to display results from their investigations of some problem or principle of science. The initiative, creativity and persistence demanded as well as this early exposure to Botany and Botanists is likely to have a long-range effect in the life of the participants.

Only the Botanical Society singles out the projects involving plants for awards. Thus, we play an important role in promoting Botany for Hawaiian secondary students. Student projects run the range of physiological and biochemical studies to testing whether rock or classical music produces better growth in bean plants. The latter projects rarely win.....

This year, "Best of Fair" as well as "Best Junior High Division" was awarded to Suzette S. F. Lee and Kathleen Y. Sakaguchi of Kawananakoa Intermediate for their project "Effects of Mycorrhizae on pigeon pea plants grown in different levels of phosphorous." Their awarded included \$45, a copy of Cronquist's Hawaii: A Natural History, and a perpetual trophy to be displayed at their school for one year. Although these students are only seventh graders, they showed the promise of being excellent Botanists. "Best Senior High Division" went to Keith F. Vendetta and Michelle M. Vierra of Waianae High for their project "Seaweed: Hawaii's future energy resource". With the chair of the Science Fair Committee a Phycologist, it's no wonder seaweed projects have won prizes each of the last three years!

For those students whose projects were meritorious, but not the best for their division, "Botanical Society Awards" (which carry a prize of \$25) were given. These prizes were awarded to Elaine Lee, McKinley High, "Soursops amylase breakdown and activity;" Tina P. Chun and Bernadette S. L. Hee., Sacred Hearts High, "Effect of root-knot nematodes;" Kamla Fukushima, Baldwin High, "The effects of inorganic vs. organic fertilizers;" Michele M. Murota, Waialua High, "Brackish Water: A future source for plant irrigation" and Edward M. Kim, Aliamanu Intermediate, "Mung Bean Growth."

Botanical Society judges for 1985 were Bill Brostoff and Alvin Yoshinaga.

KUDOS FOR BEATRICE KRAUSS

WHEREAS, Miss Beatrice H. Krauss, educator, historian, volunteer, and friend of all environmentalists, has made outstanding contributions to the field to ethnobotany, the study of the role of plants and plant products in various cultures, an area of great significance to Hawai'i; and

WHEREAS, she has spent close to 60 years in teaching and conducting original and specialized research, has written numerous monographs, brochures, articles, and bibliographies, including the two-hundred-and-fifty page syllabus, Ethnobotany of Hawai'i; and

WHEREAS, Miss Krauss has given unselfishly of her time to help people understand their interaction with their environment, not only as a valued researcher and educator at the Pineapple Research Institute and the University of Hawaii for nearly 50 years, but also as a leader in the community; and

WHEREAS, she has contributed her time and talents generously as a lecturer and resource person for the Moanalua Gardens Foundation, as well as Lyon Arboretum, Manoa History Project, Historic Hawai'i Foundation's Manoa Home Tours, Foster Garden, Pacific Tropical Botanical Garden, state and local science fairs, Blood Bank, and for numerous other organizations and individuals;

NOW, THEREFORE, BE IT RESOLVED THAT MOANALUA GARDENS FOUNDATION HONOR MISS KRAUSS, FOR HER DISTINGUISHED LIFETIME OF SELFLESS WORK AS AN EDUCATOR, ETHNOBOTANIST, HISTORIAN AND FRIEND OF ALL ENVIRONMENTALISTS, WITH ITS KUKUI O LOTA AWARD, THE KUKUI BEING A SYMBOL OF BOTH HEALING AND ENLIGHTENMENT; AND

BE IT FURTHER RESOLVED that Miss Krauss be made an Honorary Life Member of Moanalua Gardens Foundation and be presented with this resolution at the Fifteenth Annual Meeting of the Moanalua Gardens Foundation on April 20, 1985.

Harriet D. Baldwin, President
Leslie Nakashima, Secretary
Mary Ann Lentz, Executive Director
Lorin T. Gill, Education Director

PROSPECTUS OF A MONOGRAPH
OF THE HAWAIIAN MADIINAE (ASTERACEAE):
ARGYROXIPHIMUM, DUBAUTIA, AND WILKESIA¹

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The Hawaiian endemic genera Argyroxiphium, Dubautia, and Wilkesia comprise an extremely diverse, yet monophyletic group of 28 species. The nearest relatives of this assemblage appear to be the Pacific Coast tarweeds (Madiinae) of North America. Life forms represented among the Hawaiian alliance include cushion plants, mat-forming subshrubs, shrubs, monocarpic and polycarpic rosette shrubs, trees, and a liana. This array of life forms occupies a multitude of habitats ranging from the very driest to the very wettest in the islands at elevations extending from near sea level to 3,750 m. The diversity of habit and habitat is also paralleled by considerable variation in the anatomical features of these plants. Anatomical data are reviewed in the context of the present taxonomy. A summary of existing chromosome number reports for these genera, together with 47 new counts, indicates that 18 species have $n=14$ chromosomes while 9 species have $n=13$. Biosystematic and cytogenetic studies further indicate that the 14-paired genome has evolved to produce at least four chromosome races which are differentiated by reciprocal chromosome translocations. Studies of physiological ecology demonstrate that the 13-paired species exhibit altered tissue osmotic and elastic properties compared to the 14-paired species. In spite of this remarkable overall diversity, 35 different naturally occurring interspecific and intergeneric hybrids have been detected. Even the most sterile of these are capable of producing F_2 offspring. An additional 29 unique interspecific and intergeneric hybrid combinations have been produced artificially. The extraordinary diversity exhibited by this genetically cohesive group makes the Hawaiian Madiinae a premier example of adaptive radiation.

The taxonomic treatment recognizes 3 genera, 28 species, and 13 additional subspecies and lists 37

¹Carr, Gerald D. 1985. Monograph of the Hawaiian Madiinae (Asteraceae): Argyroxiphium, Dubautia, and Wilkesia. Allertonia (In Press).

heterotypic names in synonymy. A distribution map and leaf illustration is provided for each taxon. Illustrations representing various other features of the alliance are also included. One subspecies each of Dubautia ciliolata, D. imbricata, D. knudsenii, and D. plantaginea are described as new taxa. A total of 28 previously described heterotypic taxa are considered to represent spontaneous F_1 hybrids. These are listed in synonymy in an appendix that provides an account of the 35 known natural hybrids. Cytotaxonomic notes on hybrids are also provided where data are available. Finally, a list providing the identification of all numbered exsiccatae observed during the study is included.

TAXONOMIC CONSPECTUS

1. ARGYROXIPHUM DC.

1. A. grayanum (Hillebrand) Degener
2. A. virescens Hillebrand
3. A. kauense (Rock & Neal) Degener & I. Degener
4. A. caliginis C. Forbes
5. A. sandwicense DC. (2 subsp.)

2. WILKESIA A. Gray

1. W. hobdyi H. St. John
2. W. gymnoxiphium A. Gray

3. DUBAUTIA Gaudich.

1. D. laxa Hook. & Arn. (4 subsp.)
2. D. laevigata A. Gray
3. D. paleata A. Gray
4. D. raillardiodioides Hillebrand
5. D. waialealae Rock
6. D. imbricata H. St. John & G. Carr (2 subsp.)
7. D. plantaginea Gaudich. (3 subsp.)
8. D. microcephala Skottsb.
9. D. knudsenii Hillebrand (3 subsp.)
10. D. pauciflorula H. St. John & G. Carr
11. D. latifolia (A. Gray) Keck
12. D. scabra (DC.) Keck (2 subsp.)
13. D. ciliolata (DC.) Keck (2 subsp.)
14. D. herbstobatae G. Carr
15. D. linearis (Gaudich.) Keck (3 subsp.)
16. D. sherffiana Fosb.
17. D. reticulata (Sherff) Keck
18. D. dolosa (Degener & Sherff ex Sherff) G. Carr
19. D. menziesii (A. Gray) Keck
20. D. arborea (A. Gray) Keck
21. D. platyphylla (A. Gray) Keck

THE DECLINING FOREST COVER OF THE KO'OLAU SUMMIT

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In the 1930's waterfalls usually could be seen cascading down the mountainside as one drove up Nu'uau Valley to the Pali Lookout. Today only a heavy downpour would duplicate this condition. The late C. Montague Cooke, an eminent malacologist and field observer, had a very plausible explanation. He felt tree cover, especially 'ohi'a lehua (Metrosideros), in the cloud forest was quite depleted and thus moisture could not be condensed from fog and released as water droplets into the substrate at a steady rate (pers. comm.).

After traversing much of the Ko'olau summit area in recent months (Dec. to Apr. 1984-85), the Cooke hypothesis seems more of a reality than speculation. Much of the northern and central Ko'olau Range during the winter resembled a muddy obstacle course while the southern portion remained relatively dry even during and after precipitation. Much of the night and morning cloud cover do not seem to be captured by the sparse vegetational cover in the southern range. This failure correlates well with the depleted cover of 'ohi'a lehua today.

In the past when one stood under tree cover in the fog, condensed water droplets would saturate one's clothing. Today most of this available moisture passes over because the trees are gone. The little condensation is blown away or evaporated by the persistent wind action. The moisture laden tradewinds (north-easterlies) are not depositing their moisture as in the past. Only a Kona (south-easterly) to a westerly rain-storm would seem to deposit sufficient moisture on the summit areas. The only exception are pockets of native (Metrosideros) tree-covered peaks along the Ko'olau crests.

Much of the vegetational cover is changing rapidly. Most of the common understory vegetation are depleted today in the southern Ko'olau summit areas probably because of the lack of fog drip. Nertera, Peperomia, Cyrtandra, and Lycopodium serratum, so abundant twenty-five years ago, must be sought out and found with difficulty in many areas. Shrubby vegetation once common on the windward slopes is depleted in areas where low tree cover has disappeared. This situation is duplicated near the summit areas of the leeward slopes.

What do the foregoing observations suggest? Most likely a changing forest ecosystem. Many of the species seem to be on their last legs in their habitat. Their numbers are rapidly decreasing and regeneration, if any, is almost non-existent. The vacated habitats are displaced by exotic flora. The most aggressive ones presently are the Clidemia hirta (Koster's Curse) and exotic grasses. Several other exotic shrubs and tree species are also invading the area.

But the changing vegetation lacks the fog interception capabilities of a Metrosideros tree cover. Perhaps the drought of 1983-84 would not have been as severe had nature's condensation system been effective. Is this a prelude of later droughts to come? The implications are very sobering.

CURRENT RESEARCH NEWS

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I am currently working on projects involving native Hawaiian species as well as Koa Haole (Leucaena leucocephala). Both of these studies were initiated in spring 1983, and I am hoping to complete the majority of the research before I leave on about June 1, 1985. The primary objective of native plant project is to compare stomatal behavior and gas exchange characteristics in a closely related evolutionary group such as the Euphorbia. I am especially interested in determining the significance of stomatal distribution patterns on plant water and carbon-dioxide exchange (e.g. amphistomy vs. hypostomy), and relating these differences to habitat.

The leucaena project is a collaborative effort with R. S. Huang and R. Yost in the Dept. of Agronomy that focuses on the influence of phosphorus nutrition and mycorrhizal infection on water relations and photosynthesis. We are looking in detail at the interactions between net photosynthesis and P-uptake in young seedlings during the establishment phase. Also, we have found that leaf orientational properties serve as a sensitive indicator of physiological status and have a major influence on water-use efficiency.

SOME COMMENTS ON THE HISTROY OF BOTANY IN HAWAI'I

Dr. St. John on May 6, 1985 reviewed the history of expeditions and collections of Hawaiian plants between 1835 and 1871. The first collector was THOMAS NUTTALL, originally from England, whose name is commemorated in the names of many plants in the western part of North America, and who was in Hawai'i in 1835. He was in Hawai'i for about 4 months, visiting Kaua'i, 'O'ahu and Hawai'i. He collected 130 species, about half of them thought to be new. In 1837, HMS Sulphur, with G. BARCLAY and B. HINDS as collectors, visited Hawai'i and 'O'ahu for four months. The collections were not included by Bentham in "The Botany of the Sulphur".

CHARLES WILKES, the Navy captain in charge of the U.S. Exploring Expedition brought six vessels to Hawai'i, beginning in 1838. Among scientists associated with this Expedition were ASA GRAY, JAMES D. DANA, CHARLES PICKERING, and WILLIAM BRACKENRIDGE. The expedition was in Hawai'i for nine months, visiting all of the major islands. What must have been the very slowest trip to be made between Hilo and Kilauea was led by the irascible Wilkes: it took 30 days! T. DIDRICKSEN of the Danish Galathea expedition visited 'O'ahu and Hawai'i Islands for two months in 1846. The collections were never looked at until found by C. Skottsberg in the Copenhagen Museum 100 years later. Most of the collections consist of specimens of Hawaiian mosses. The first collection of plants from Kaho'olawe, and before the introduction of hoofed animals, was made by JULES REMY who was in Hawai'i between 1851 and 1855. He also visited the principal islands and Ni'ihau. Remy's collections are mostly in the Paris Museum, with one set of duplicates at Harvard. Remy was an ethnologist as well as naturalist; he wrote a dictionary of Hawaiian, but did not publish on Hawaiian botany.

The last of Dr. St. John's botanists was the best known of all to students of Hawaiian botany, WILLIAM HILLEBRAND, who lived in Hawai'i between 1851 and 1871. Among fortunate happenings, Hillebrand sent between 700 and 800 numbers of specimens to the Kew Herbarium in London. These plants represent the main surviving Hillebrand collection which otherwise had been stored at the Berlin herbarium which was destroyed in the Second World War. Another tidbit: money was appropriated by the Hawaiian legislature to build a fountain in celebration of Hillebrand's published Flora of the Hawaiian Islands. The fountain was never built.

THE MAUNA KEA SILVERSWORD:
A SPECIES ON THE BRINK OF EXTINCTION

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HISTORY

In the early nineteenth century, it took a sizable amount of effort to climb on foot Hawai'i's highest volcano, Mauna Kea, rising 13,796 feet (4200 m) above sea level. Yet, James Macrae, employed by the Horticulture Society of London, did just that in 1825. Even with all the problems Macrae encountered on his journey up Mauna Kea, the foggy cold, members of his party succumbing to altitude sickness, and miles of hard-going over loose lava cinders, Macrae wrote:

The last mile was destitute of vegetation except one plant of the Syginesia tribe, in growth much like a yucca, with sharp pointed silver coloured leaves and green upright spike of three or four feet producing pendulous branches with brown flowers, truly superb, and almost worth the journey of coming here to see it on purpose (Wilson, 1922).

Macrae had found one of Hawai'i's most striking plants in flower. His collection of this plant was eventually sent to De Candolle in Geneva who in 1836 described the plant for the first time and gave it the genus name Argyroxiphium, which is Greek for silversword. Thus, the scientific community first learned about the magnificent Hawaiian silverswords, unusual giant rosette alpine plants of the composite family, the result of millions of years of isolated evolution on the Hawaiian island chain. Argyroxiphium represents one of three endemic Hawaiian genera of 29 species called the silversword alliance, acclaimed as the most spectacular example of adaptive radiation in plants known to science (Carr and Kyhos, 1981).

Today, with 4-wheel drive and roads to take one up Mauna Kea, it is no less inspiring for a modern day botanist to make the long journey to see the botanical wonders that may still be found there. However, seeing the Mauna Kea silversword, A. sandwicense DC., is not as likely to be an experience of awe as it is of grief: The species is nearly extinct.

The original range and abundance of the Mauna Kea silversword is enshrouded in mystery. We can only guess

from historical accounts and speculation where it must have grown. However, it appears that the range of the species had, at one time, circled Mauna Kea in a band between about 9,000 feet (2740 m) and about 13,000 feet (3960 m) in elevation.

Historical accounts of the silversword are few and full of foreboding. Unfortunately, this is most of what we know: In 1890, W. D. Alexander climbed to the summit of Mauna Kea and wrote, "The beautiful silversword, once so abundant is nearly extinct except in the most rugged and inaccessible localities" (Alexander, 1892). Joseph Rock, 1913, wrote, "They still occur in the thousands in Haleakala Crater, but are indeed very scarce on Mauna Kea." In 1910, Rock collected a specimen "above Horner's Ranch near Puu Lehu" on the north slope of Mauna Kea (BISH #8434). Carl Skottsberg found dead silversword plants on the west flank of Mauna Kea at about 9,000 feet (2740 m) in 1922 (Skottsberg, 1926). Skottsberg wrote, "I do not know what had befallen these plants. They were not old ones that had flowered and then died." In 1925 and 1926, a member of the US Geological Survey, preparing a topographical map of Mauna Kea, found silverswords in 2 locations, at an elevation of 10,500 feet (3200 m) in the Wailuku river course and at 11,650 feet (3550 m) in Pohakuloa gulch (Kilmartin, 1975).

A 1935 survey of the ecology and vegetation of Mauna Kea by Constance Hartt and Marie Neal revealed 1 live silversword plant at 12,250 feet (3730 m) elevation near the Humuula trail, of which they wrote, "was growing on a rocky shelf in a position well protected from grazing animals." Marie Neal also found remains of dead silverswords on the northwest slope of the mountain near tree line (Hartt and Neal, 1940). Hawaii District Forester, L. W. Bryan, counted 27 plants in the Wailuku Gulch on the steep cliffs in 1951. He also noted seeing a plant above Kanakaleonui in 1950, and one mauka of Kahinahina cabin in 1955 (Bryan, 1971). It appears that even by the time of its first collection by a European in 1825, the Mauna Kea silversword was already seriously declining due to the grazing impacts of introduced feral sheep (Ovis aries).

Captain George Vancouver landed Hawai'i's first cattle (Bos taurus) and sheep as gifts for King Kamehameha I at Kealakukua Bay and Kawaihae on the island of Hawai'i in his 1773 -1774 visits (Wilson, 1920). Vancouver convinced the king that he should place a kapu on killing the animals in order to let them increase. Although it is historically noted that not everyone heeded Kamehameha's prohibition, the number of feral

sheep increased enormously and they migrated throughout the island over the next 20 to 30 years (Kramer, 1971).

When sheep had begun inhabiting the upper slopes of Mauna Kea is unclear. Due to hunting pressures, the feral grazers were probably driven into the higher elevations, which were prime silversword habitats. Introduced feral sheep probably daily moved to higher areas above tree line at night to escape predation by man or feral dogs (Canis familiaris) and migrated below tree line into better pasture areas during the day (Giffin, 1976). Consequentially, grazing pressures were mainly at tree line in the high elevation mamane (Sophora chrysophylla) forest. Regarding the summit of Mauna Kea, Macrae wrote in his 1825 diary:

I stayed about an hour admiring the scenery. For the space of about 12 miles around the top of the mountain, it was dreary to a degree, but below that, the pasture where the wild cattle fed had a pleasing effect. The forest which encircles the island of Hawai'i below the pasture land was hidden in fog... I saw many skeletons of some kind of animal, devoid of all flesh, but apparently not long dead, and on rejoining our guide, was informed that the wild dogs had almost exterminated the sheep that Vancouver had brought with the cattle, pursuing them beyond the line of vegetation, where they became bewildered and died for want of food (Wilson, 1922).

Here is evidence that feral sheep had made it to the summit of Mauna Kea long before Macrae had. One has to wonder, knowing today that feral sheep find silverswords quite palatable forage, if those animals pursued "beyond the line of vegetation" had helped themselves to available silverswords before dying "for want of food" or water.

Despite the presence of wild dogs, the sheep increased in numbers on Mauna Kea. In 1851, there were an estimated 3,000 of them. At this time, there were an estimated 12,000 feral cattle on the mountain. The fates of these two feral ungulates diverged. Cattle ranching became a big industry between 1850 and 1886 on the island of Hawai'i. By 1921, feral cattle were out of favor as forest despoilers and competitors with domesticated cattle, and were eliminated on Mauna Kea by 1942 (Tomich, 1969). On the other hand, feral sheep, the numbers of which were somewhat kept in check by feral dogs, increased in numbers enormously after 1920 when the dogs were exterminated by a poisoning program instituted by commercial sheep raisers (Tomich, 1969). By 1937, there were an estimated 40,000 feral sheep on Mauna Kea (Bryan, 1937). Most of these animals were contained within the

Mauna Kea Forest Reserve which encompasses the mountain from about the 7,000 - 8,000 foot (2130 - 2440 m) contour to the summit. This area includes the probable original range of the silversword.

From 1950 until 1981 feral sheep were managed and maintained as a game animal for sport hunting on Mauna Kea. The average number of sheep during these years fluctuated between 4,000 and 11,000 animals (Walker, 1974; Giffin, 1976). In 1981, a federal court's decision in favor of the Palila (Psittirostra bailleui), an endangered bird dependent on the Mauna Kea mamane forest, forced the Hawaii State Department of Land and Natural Resources (DLNR) to eliminate all feral sheep on Mauna Kea. Today, perhaps 60 hunter-shy sheep remain (R. Walker, pers. comm.).

The Mauna Kea silversword should have been a beneficiary of the Palila suit, but the species has yet another adversary. Mouflon sheep (Ovis musimon) were introduced to Hawai'i as a game animal in 1954. Between 1958 and 1962, an attempt was made by the DLNR to hybridize mouflon with feral sheep. The intention was to breed an animal that was better hunting sport than feral sheep, but that gathered in smaller bands and therefore would be less damaging to the forests as grazers (Walker, 1960). This attempt, for the most part, failed. Although mouflon and feral sheep did interbreed and produce fertile hybrid animals, the two species of sheep preferred to breed with their own kinds. Starting in 1962, pure mouflon and hybrids were released from pens in Pu'u La'au and Kahinahina.

There are an estimated 500 mouflon on Mauna Kea today. These ungulates are maintained by the DLNR as a sport game animal. Mouflon sheep are as fond of grazing on silverswords as were the feral sheep and they are more agile. They can jump fences capable of excluding feral sheep and can negotiate steep-walled gulches and cliff faces feral sheep could not traverse. The silverswords have been helpless against these animals. Only those plants growing in places inaccessible to feral sheep and mouflon have escaped destruction. Today, there is only one known remnant population of the Mauna Kea silversword, on the steep cliff banks of the Wailuku River Gulch.

RESTORATION ATTEMPTS

The silversword of Mauna Kea may have quietly slipped into oblivion, but at the eleventh hour there was renewed interest in its plight.

On September 15, 1971, Mr. Kaoru Sunada, a long time silversword enthusiast, journeyed to the Wailuku Gulch to see the then almost legendary silverswords. According to Mr. Sunada (pers. comm.) there were 60 to 80 plants remaining. As a result of this journey, a newspaper article was published in October, 1971 on the Mauna Kea silversword in which it was suggested that fencing of the remaining population to exclude feral sheep may prevent imminent extinction of the species (Anonymous, 1971). This, however, was not a totally new idea. Foresters had been aware for many years that sheep were harmful to silverswords and that fencing was necessary (Anonymous, 1951). Mr. Sunada went to work to save the Mauna Kea silversword. He obtained support in the state legislature for a fencing project and there was also interest in a restoration program in the State Division of Forestry.

Forester Charles Wakida inspected the Wailuku site in November, 1971, and reported seeing 15 to 20 plants. He stated in his report, "The silverswords exist only on the steep ledges inaccessible to the sheep. I also saw a couple that were barely within reach and partially eaten." (Wakida, 1971).

The 1972 Hawaii State Legislature appropriated \$40,000 to be used by the DLNR to "construct fencing for the preservation of foliage and wildlife (mammal, silversword) at Kalopa State Park and Mauna Kea" (Act 176 SHL 1972). In that year, a 2.5 acre sheep enclosure was built at 9,000 feet (2740 m) on the bank of the Wailuku gulch in conjunction with the U. S. Forest Service to be used for growing silverswords and for experiments on mamane forest and grassland regeneration in the absence of sheep (Scowcroft, 1983).

In the summer of 1973, three plants flowered providing seed usable for restorative propagation. Forestry personnel, as well as Mr. Sunada, collected seed from the 1973 flowering plants, providing the nucleus for what was to become a restoration program (Landgraf, 1974). They soon discovered that growing the alpine plant in Hilo was impossible, and the seed was given to the Hawaii Volcanoes National Park on April 23, 1974. Here, in the cooler, higher elevation environment of the National Park, silverswords were grown in the Park greenhouse complex.

In December, 1973, greenhouse-grown silverswords were first planted on Mauna Kea within the mamane enclosure. This first attempt to restore the silversword population was unsuccessful, as all the plants died

during the winter due to frost heaving. In June, 1974, however, a single seedling was noticed within the mamane exclosure that had survived as a result of direct seeding (DLNR, 1974). In December of that year, 10 plants were planted within the mamane exclosure. Two of these plants reportedly flowered in 1978 (DLNR, 1978).

The 1974 State Legislature appropriated another \$25,000 to the DLNR for the purpose of "fencing and stocking of silverswords and other endangered species of plants and animals on the Island of Hawai'i for protection and propagation." Part of this appropriation was used to erect a 50 acre sheep exclosure surrounding the Wailuku Gulch and adjacent areas in 1975. In the fall of 1975 and early 1976, 275 seedlings that had been grown in Hawaii Volcanoes National Park were planted in the protected area. Half of these were reportedly destroyed by mouflon sheep by June of 1976 (Wakida, 1976). In March, 1982, more seedlings were planted on Mauna Kea from those grown at Hawaii Volcanoes National Park. It was noted by Mr. Wakida that there were five surviving natural seedlings from the 1981 seed crop (Wakida, 1982).

CURRENT STATUS AND ECOLOGY

Several aspects of Argyroxiphium biology are worth scrutiny in evaluating current status: Demographic structure, monocarpism, self-incompatibility, sibling incompatibility, pollination, population size, unanticipated effects of artificial propagation, and habitat.

On August 18, 1984, I visited the Wailuku site in the company of three other botanists. We found a total of 110 plants of all size classes. Fifteen of these are probably all that remain of the natural population. The other 95 plants are apparently out-planted nursery stock. The rosette diameters of 84 silverswords were measured. The sample included the few naturally occurring as well as planted individuals. The demographic structure of this population is that of a non-regenerating population. Only 8% of the plants were in the seedling size class (1-9 cm diameter) and 51% of the plants were in the mature size class (30+ cm diameter). The demographic structure of this population contrasts with that of a sampled population (n=500) of the Mauna Kea silversword's closest and most famous relative, the Haleakala silversword, A. macrocephalum Gray (See Figure 2). The structure of the sampled population of the Haleakala silversword is typical of a regenerating species. Fifty-five percent of the

individuals sampled were in the seedling size class (1-9 cm diameter) and 9% were in the mature (30+cm diameter) size class. Although, it is unclear just how many silverswords there were in Haleakala National Park before protection from human collection and feral goats was instituted, ecological studies begun in 1969 show that the population there has been increasing naturally at a rate of approximately 1% per year (Kobayashi, 1973; Loope and Crivellone, unpublished).

One of the unique aspects of the Hawaiian silverswords is their life history. Like the famed century plant, three of the five extant species of Argyroxiphium are basically monocarpic. This means that the plant lives as a basal rosette for many years, increasing in diameter and maturity. When the right stage of maturity is reached, or the plant responds to some, as yet, unknown cues, it flowers. Following flowering and fruiting, the entire plant dies. Reproduction of these monocarpic plants is, therefore, accomplished by a single fruiting event.

In a population of monocarpic silverswords, a few individuals may be found that express a branched habit reminiscent of their shrubby ancestry. Some plants branch naturally or as a result of damage to the apical meristem. A multi-rosette plant may flower over several years as each rosette or branch matures. How frequently the branched form occurred naturally in the Mauna Kea silversword is not known. The occurrence of this form in the Haleakala silversword is rare. However, it was from such a multi-rosette plant that a large quantity of the seed for the Mauna Kea silversword restoration project was collected (K. Sunada, pers. comm.). Of the 95 plants growing now on Mauna Kea that appear to be the result of the restoration program, 66 are multi-rosette plants. All of the 15 silverswords of presumed natural origin are single rosette plants. It is possible that inadvertent selection by man for the multi-rosette habit has increased the frequency of that character in the Wailuku River population.

Seed set in the Mauna Kea silversword is low. I found a seed set of 3% from seed samples collected from the plants that flowered in 1983 and a seed set of 2% from seed samples collected from plants flowering in 1984. This level of seed set contrasts with a seed set of 6 - 50% typically found in the Haleakala silversword (Kobayashi, 1974; Loope, unpublished; Powell, unpublished).

Several factors may be responsible for the low level of seed set in the Mauna Kea silversword. The Mauna Kea silversword is probably self-incompatible, as is the Haleakala silversword (Carr, Powell, and Kyhos, unpublished). This means that the plants are incapable of self-fertilization and must rely on a pollination vector and a nearby flowering companion for viable seed set. Low population size and concurrent low pollinator interest or pollinator extinction could explain the depressed seed set. It is also possible that these plants are experiencing reduced seed set as a result of possessing a sporophytic incompatibility system. In such a system, up to 50% of the possible combinations of sibling matings may be incompatible. The restored plants, most of which are derived from one or two parents, are probably all either siblings, half-siblings, or progeny of sibling crosses. Another possibility is that the low seed set is a natural consequence of the newly encouraged perennial branched habit. Multi-rosette plants may put less energy into seed production for each repeated flowering event than monocarpic plants expend in a single suicidal flowering and fruiting episode.

Even with the low seed set in these plants, ample regeneration is hypothetically possible. A blooming Mauna Kea silversword produces, on average, over 44,000 achenes (Meyrat, 1984). At just 2 percent seed set and a germination and seedling mortality rate typical of the Haleakala silversword (Kobayashi, 1973), about 200 progeny could conceivably result from one flowering plant. However, natural regeneration within the exclosure is extremely low. Although it is possible that tiny seedlings could have been overlooked in the August, 1984 census, this is not likely since any sign of regeneration of natural or restored plants was of particular interest and was carefully sought. Only out-planted individuals showed any signs of regenerating naturally. Within the 2.5 acre mamane exclosure, plants of all size classes were found. These are probably a result of natural regeneration as well as planting programs which have continually provided plants in the sub-mature size classes. Only two seedlings were found in the 50 acre exclosure.

Why is natural regeneration not occurring on Mauna Kea? For the answer to this question we need to look at the ecology of a plant that is very close to extinction. It is highly likely that the fenced area at the Wailuku Gulch which has fine-textured ash-derived soil is in reality a last refuge for the silversword and not an ideal habitat. To my knowledge, no attempt has been made to restore silverswords on the high elevation cinder

slopes. The cinder cones and slopes have a different substrate than is found at the Wailuku site. Kobayashi (1973) found that Haleakala silversword regeneration was highest in areas where a layer of cinders of 5 cm or less diameter covered a sandy soil. Such characteristics prevail on cinder slopes and would probably provide optimum conditions for regeneration of the Mauna Kea silversword as well.

One factor negatively affecting the silverswords, however, is well known. Even as rare as it is, the Mauna Kea silversword is sought out and grazed by mouflon sheep. Evidence of recent grazing by mouflon can be found today, as mouflon continue to jump the fence, graze leaves and uproot plants within the enclosure. It appears that the remaining 15 wild plants are inaccessible to mouflon. Indeed, it appears that if they were not, they would probably not be in existence today. Unfortunately, it is likely that most seeds produced will fall into areas readily accessible by mouflon, judging from tracks found up to a few meters of most surviving plants.

FUTURE

After over 150 years of decline and several of governmental neglect, the Mauna Kea silversword has finally broken out of the bureaucratic maze. On March 6, 1985 a proposed ruling determining the Mauna Kea silversword an endangered species was published in the Federal Register. Within one year of this proposed ruling the silversword may be officially listed as an endangered species. This is good news for all silversword admirers. There appeared to be little hope for the survival of the Mauna Kea silversword as a species without the protection of the Endangered Species Act.

Following listing as an endangered species, the Mauna Kea silversword may have the benefit of a U.S. Fish and Wildlife recovery plan. The purpose of a recovery plan is to restore the endangered species to the point where it is no longer endangered. The State of Hawaii is faced with a conflict in any attempt to restore the the Mauna Kea silversword in its original habitat if the DLNR continues to maintain mouflon sheep on Mauna Kea. The State must decide whether to maintain mouflon for the pleasure of a few hunters or to support the preservation and restoration of the endangered silversword. We cannot have both.

However, if the mouflon are removed from Mauna Kea, and a careful recovery plan that takes into account the special ecological needs and attributes of the Mauna Kea silversword is put into action, it may be possible once again, for the silversword to grow and prosper on Mauna Kea, inspiring poetry in the hearts of Hawai'i's people and "worth the journey to see it on purpose."

ACKNOWLEDGMENTS

This research was supported in large part by National Science Foundation grant BSR-8306917 to Dr. Gerald Carr. I wish to acknowledge the courtesy of Mr. Kaoru Sunada and Mr. Charles Wakida who graciously allowed me to interview them. My most special gratitude goes to my friends, Jim Jacobi, Lani Stemmermann, and particularly Rick Warshauer, who gave me invaluable advice, encouragement, and logistical support.

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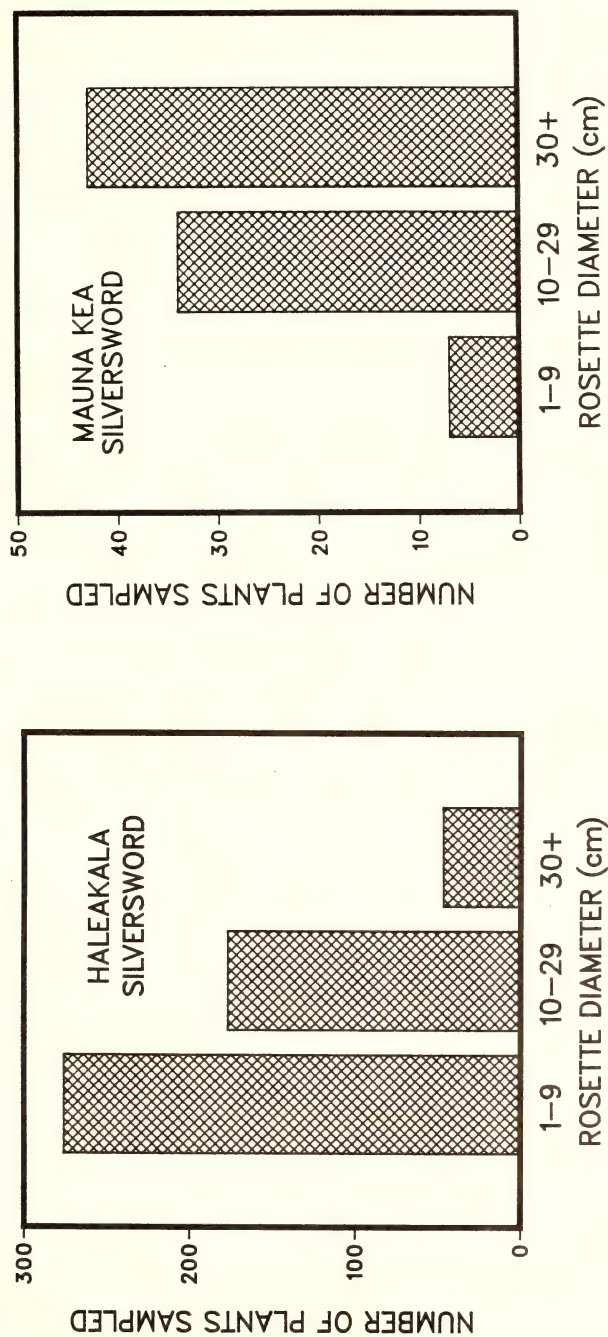


Figure 2. The number of plants sampled in three categories of rosette diameter size classes: Seedling (1-9cm); Sub-mature (10-29cm); and, Mature (30+cm). The total number of plants sampled of the Haleakala silversword was 500, or about 1% of an estimated total population of 50,000 individuals. The total number of plants sampled of the Mauna Kea silversword was 84, or 76% of the total known population.

HERBARIUM PACIFICUM (BISHOP MUSEUM)

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Department of Botany
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P.O. Box 19000-A
Honolulu HI 96819

Activity in the Herbarium Pacificum continues at a high level with five major grant-supported projects underway: Flora Project; Doty Algal Project; Type Catalog Project; In Gardens of Hawaii-II Project; and, Psychotria of Malesia project. General herbarium activity has continued at a high level and in calendar year 1984, there were 76 loans of 6,395 specimens sent out, 61 loans of 6,139 specimens received, 30 exchange transactions of 3,631 specimens received and 24 exchange transactions of 3,537 specimens sent out. There were also 476 person-day research visits to the herbarium in 1984 as well as 229 person-day educational tours during the same period. Those of you who have been by, or who are otherwise aware of our activities, also know that further significant inroads have been made into our backlog; we recently, for example, completed the processing of the Kondo Solomon Island Collections that had been around since the early part of the 1950's.

The Flora Project is at a point where the end is beginning to be visible and if all goes well we expect to have the Manual of the Flowering Plants of Hawai'i published in 1988, the centennial of Hillebrand's flora. New combinations, new records of naturalized plants, new taxa, etc. will appear in a six-part contribution to the Bishop Museum's Occasional Papers Series to provide information prior to the publication of the Manual. Those interested should look for Susan Mill, Warren Wagner, and Derral Herbst's contribution to Taxon (Vol. 34, No. 2) dealing with the "Bibliography of Otto and Isa Degener's Hawaiian Floras." The bibliography will provide a handy index to the (at present) Degener's 1,152 separate articles treating 823 species of plants. This project is part of a larger project to provide a complete bibliography of literature on the native and naturalized flowering plants of Hawaii.

The Doty Algal Project is part of a National Science Foundation (NSF) grant that is allowing us to provide for the complete curation and integration of the spirit-preserved algal specimens (some 13,500 specimens) that were part of the Doty Algal Collection donated to Herbarium Pacificum. This NSF grant is also allowing us to create a computerized index to the Type Collection of

the Herbarium Pacificum; a project in which the status of the specimens in the Type Collection will be verified and curated as well. Peter O'Connor, Collections Manager of the Herbarium Pacificum, is project director and is carrying out this task with the support and collaboration of Jane Medler, Research Associate.

On 1 January 1985, S. H. Sohmer officially inaugurated the In Gardens of Hawai'i-II project with Horace Clay and Derral Herbst as principal authors and Rylan Yee as Assistant Botanist. The project will encompass a three-year period in which Marie Neal's popular work, In Gardens of Hawai'i, is to be completely revised. If you are interested in news of this project, call the Museum at 847-3511 and ask for Horace Clay.

S. H. Sohmer has been engaged with the genus Psychotria (Straussia is a synonym in Hawaii) for 10 years, and is presently, with the assistance of Christa Russell, on the second year of an NSF grant to revise the Malesian Psychotria. Malesia is a phytogeographic area of the world that encompasses the present nation of Malaysia, Indonesia, Papua New Guinea, and the Philippines. This area is probably the ultimate source area for nearly all of the Pacific Psychotria, including Hawai'i. Sohmer and Russell are now engaged with enumerating the species of Psychotria found in the Philippines.

HAWAIIAN MUSHROOMS

The masters thesis, "A Floristic Survey of Fleshy Fungi from the Hawaiian Islands" has just been completed at Southern Illinois University, Carbondale, Illinois, by Michael Doyle. Michael has been collecting agarics (mushrooms) in native forest areas in Hawai'i since 1979 and is here again through early June. He soon begins his Ph.D. with full scholarship under Dr. Sherwin Carlquist at Claremont in California. Michael can be contacted through the Botany Department at University of Hawaii.

BOTSOC FIELD TRIP TO LYON ARBORETUM

9:00 A.M. SATURDAY, MAY 25

Ray Baker will lead interested people through Arboretum plantings and up into their falls area where efforts are underway to restore native vegetation. The Hawaiian Entomological Society has been invited to join us. There will be a potluck lunch afterward with beverages and utensils provided. Parking is limited, please carpool. Come for a close look at the Arboretum! Any questions may be referred to Jane Lewis (948-8315).

INTERNATIONAL BOTANICAL SOCIETY
C/O DEPARTMENT OF BOTANY
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Hawaiian Botanical Society



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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

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FOSTER GARDEN ANNUAL PLANT SALE

Saturday 21 September 1985

This annual event is a must occasion for the serious gardener in Hawai'i. If you want to have a chance at the really good offerings you should be there in plenty of time to participate in the opening stampede at 9 a.m.

HAWAIIAN BOTANICAL SOCIETY MEETING
Minutes of the April, 1985 meeting

President Lewis called the meeting to order at 7:40 p.m. Minutes of the March meeting were read and approved. There was no treasurer's report.

Libby Powell of the Conservation Committee called on Society members to boycott Koa products to discourage the cutting of Koa. Libby also requested members and the general public to call "koa haole" Leucaena so that it won't be confused with the native Acacia koa.

On behalf of the Newsletter Committee, Dr. Abbott asked Society members to submit botanical information or other newsworthy notes to Dr. Smith for inclusion in the Botanical Society Newsletter.

Under old business Libby Powell announced that logging probably continues in Kokee State Park. Harvesting of 'ohi'a for wood chipping is continuing on the big island.

Under new business President Lewis asked members to fill out and return to her a Botanical Society questionnaire which will help her to assist the Society in finding a focus and initiate action towards that goal. Any comments or ideas for the Society are also welcomed and appreciated. President Lewis also announced that the Society will sponsor a field trip to Lyon Arboretum on May 25.

Society members were invited to the 6th Annual Meeting of Plant Physiologists in Hawaii which took place May 3, 1985 on the U.H. campus.

Plant of the Month Speaker was Dave Miranda of Hawaiian Sunshine Nursery. Dave gave a brief synopsis of propagation of native plants, some of which are available from his nursery.

Mr. Paul Weissich, Director of Honolulu Botanic Gardens, gave an interesting and informative update on Honolulu's Botanical Gardens, which include Wahiawa and Foster Botanic Gardens, Koko Crater, and Ho'omaluhia. Mr. Weissich's department also oversees the community gardens program and are charged with identification and maintenance of Honolulu's exceptional trees.

The meeting was adjourned at 9:00 p.m. and members then enjoyed refreshments and plant exchange.

Respectfully submitted,
Christa Russell

HAWAIIAN BOTANICAL SOCIETY MEETING
Minutes of the May, 1985 meeting

President Lewis called the meeting to order at 7:30 p.m. Minutes of the April meeting were read and approved. The May balance in the Society treasury was \$2,407.68.

President Lewis read a letter to the Society from Dr. C. W. Smith, chairman of the Native Plants Committee, regarding geothermal exploratory drilling on Campbell Estate land at Kahaualea near Hawaii Volcanoes National Park. The drilling will occur in pristine 'ohi'a forest. All wells will be upwind of Hawaii Volcanoes National Park and some will be as close as one-half mile from the park. It was recently proposed that the state swap the Waiokele Natural Area Reserve for Kahau'alea. Part of the proposal would be for the National Park Service (NPS) to purchase Tract 22 of Kahau'alea which is adjacent to the park. The state would then swap the rest of the land on an equivalent cash basis. Hawaiian Botanical Society should encourage NPS and our congressional delegation to pursue acquisition aggressively.

There were no other committee reports.

Under new business President Lewis received a letter from Welcome Fawcett concerning the rare fern Marsilea villosa which grows near Hanauma Bay. The Botanical Society was asked to conduct a survey of its habitat and to make management recommendations. Marie Brugeman surveyed the area and it was recommended that barriers be built to restrict four-wheel drive access.

Also under new business President Lewis announced that seven projects in this years junior and senior high Hawaiian Science & Engineering Fair received awards from the Botanical Society. The "Best of the Fair" as well as "Best Jr. High Division" was awarded to 2 students at Kawanakoa Intermediate School for their project "Effects of mycorrhizae on pigeon pea plants grown in different levels of phosphorous".

President Lewis announced that the Society was planning a field trip to Lyon Arboretum on Saturday, May 25. Members and the general public were invited to join the tour which was to be led by Ray Baker. A potluck lunch was to be held afterwards.

John Obata, Plant of the Month speaker, spoke on lobelias of O'ahu. John's talk, illustrated with slides, recounted some of his collecting trips made over the last 25 years in O'ahu's mountains.

Dr. St. John reviewed the "recent" history of Botany in Hawai'i beginning with Thomas Nuttall, an Englishman who landed in Honolulu in 1835, and concluding with William Hillebrand who was in Hawai'i from 1851-1871, and who is probably best known for his Flora of the Hawaiian Islands.

The meeting was adjourned at 9:00 p.m.

Respectfully submitted,
Christa Russell

WE ALMOST SAW THE LAST OF KOA HAOLE

Last year a number of us who perpetually battle against koa haole (Leucaena leucocephala) in our gardens were delighted to see that a psyllid (Heteropsylla cf. incisa) had become established which caused a severe stunting and premature leaf drop of this perennial weed. A fuller account of the entomology of this species can be found in the Hawaii Pest Reporter Vol. IV(2).

The impact of this bug in koa haole stands on the windward side of O'ahu was dramatic. Most trees were defoliated even during the wettest periods of the winter. Flowers were rarely seen and fruit set was absent. Unfortunately, the understory of old koa haole stands was soon invaded by Andropogon virginicus (bush beardgrass), Achyranthes indica, Asystasia gangetica (Chinese violet), Chloris inflata (swollen fingergrass), Ocimum basilicum (basil), Passiflora suberosa (Huehue haole), and Rivina humilis (coral berry) though the spread of the latter could also be due to dissemination by bulbuls. There was no indication of any increase in native plants in these areas.

By April, predators on these psyllids were increasingly evident, particularly the coccinellid beetle (Curinus coeruleus). Another coccinellid and two syrphid fly larvae also attack the psyllid. At the same time, the number of koa haole trees with green leaves was increasing. By June, almost every tree had some leaves during wet weather. In July flowers were evident and in some instances seeds were set. So it now looks as though the koa haole will be back as the dominant plant in many windward areas.

On examining the seed pods that have been set recently, there is no indication of any damage by the koa

seed worm (Cryptophlebia illepidia). Since there were no seed pods available last year, the seed predator probably has been reduced to very low population levels. Consequently all of the seeds set now are added to the seed bank, rather than only approximately 50% as in previous years.

The invasion of the herbaceous weeds into the old koa haole stands presents a significant new problem regarding the management of these stands. The fuel that is represented by the grasses in particular, will carry very hot fires rapidly. The fires will intensify the bush beardgrass cover and reduce the koa haole, further increasing the fire hazard in these areas.

Finally, a note on the common name of Leucaena leucocephala. St. John lists seven names in his list of flowering plants in Hawai'i. Koa haole¹ or false koa are the most commonly used. Calling it haole koa is incorrect. In Hawaiian, the adjective follows the noun it is qualifying. Ekoka is an alternative name which is used on the Big Island. There is some potential for confusion of this latter name with koa. However, if we stick to the two most commonly used names, Koa and Koa haole, then there should be no confusion. Recent suggestions to devise new names to circumvent potential confusion should be avoided.

Clifford W. Smith
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¹ Note on the word haole: Haole not only refers to certain white persons, defined as certain nationalists in Pukui & Elbert's Hawaiian Dictionary, but also to "foreigners, foreign, introduced or of foreign origin," i.e., not Hawaiian. The etymology of the word might be the following (as discussed back and forth many times by my Hawaiian Mother and her friends, though I have never heard anyone else suggest this possible derivation): in Hawaiian mythology, the ancestor of man (a sibling of the taro plant--Colocasia esculenta) was called Haloa, which is translated as meaning "long (loa)/or trembling petiole (ha)" of the taro plant. Those who are not derived from Haloa (the Hawaiian ancestor) are those who are not ('ole) Hawaiian. Some caucasoids who are new arrivals in Hawai'i are sometimes offended by the word haole: they should not be since everyone cannot be Hawaiian!

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A NEW FLOWERING PLANT RECORD

An event which is becoming increasingly more frequent during botanical field studies is the discovery of weeds new or infrequently reported. Such an event occurred in September 1984 at the Naval Air Station at Barbars Point, O'ahu (NASBP). Flaveria trinervia (Spreng.) C. Mohr, (Compositae) was found growing in an abandoned barrow pit at the western end of the station. This species was not reported from this area in the 1979 Fish and Wildlife survey of the area. It had been collected from Sand Island, O'ahu in 1971 by Derral Herbst. At NASBP there were three thriving plants which would indicate that Flaveria trinervia is now well established along the southern coast O'ahu.

Flaveria trinervia is a small branching herb from Mexico and southwestern United States. The opposite leaves are three veined, oblong and fine toothed. They are about 2.5 cm long. The flowers grow in dense narrow heads at branch tips. It appears to thrive on the dry coastal lowlands.

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A SURVEY OF QUEEN'S BEACH, O'AHU, HAWAII

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INTRODUCTION

The Queen's Beach area of O'ahu has been considered a primary development site for tourist facilities for many years. As part of preliminary planning preparation, this botanical survey of the area was conducted in July 1984.

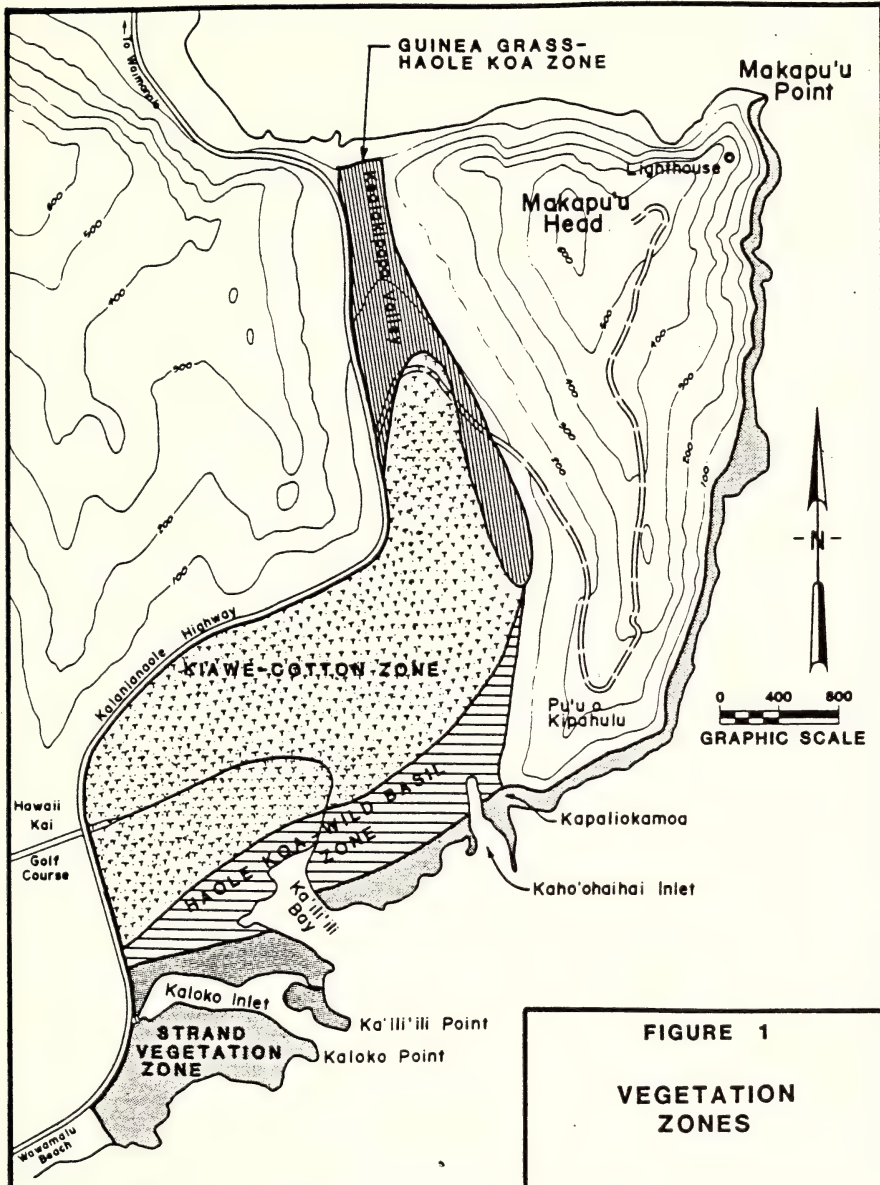
The study area included the flat, low-lying land between Makapu'u Head and Kalaniana'ole Highway, from the end of City property at Wawamalu Beach to the Makapu'u Lookout (Fig. 1). The objectives of the study were 1) Identify all plant species present; 2) Map the plant communities on the site; 3) List the status, significance, and characteristics of native plant species present on the site; 4) Discuss the status and significance of threatened and endangered native plant species, if present; 5) Recommend possible measures to protect or cultivate species on the site which may deserve special attention; and, 6) Briefly recommend and describe types of native vegetation/plants which could be utilized as landscaping in a park.

METHODOLOGY

We walked along transects which were no more than 80m apart and recorded all plants encountered. The Braun-Blanquet method was used to define percent cover from which we established the vegetation zones. (Mueller-Dombois & Ellenberg 1974)

BOTANICAL ASSESSMENT

According to the zonation scheme of Mueller-Dombois and Gagne (1975), the study area at Queen's Beach lies within the xerotropical (Coastal Flats and Lowlands) zone. In spite of heavy human impacts the area still supports a surprisingly large number of endemic (native only to Hawai'i) and indigenous (found in Hawai'i and other places) species (Table 1). However, the coastal vegetation is gradually being inundated by alien species, notably Rhizophora mangle L. (mangrove), and the dry lowlands by various alien grasses and shrubs. Other uses of the area such as unauthorized dumping of household rubbish and the unchecked wanderings of off-the-road vehicles are further degrading the vegetation.



The vegetation cover of the study area can be divided into four zones: a strand vegetation zone (SV); a koa haole - wild basil zone (HKB); a kiawe - cotton zone (KC); and, a grass - koa haole zone (GHK). The boundaries of these zones are fairly imprecise as they merge into each other, but from some vantage point such as Pu'u o Kipahulu they are clearly discernible (Fig. 1).

The strand vegetation zone begins at the rock and concrete barricade at the Wawamalu Beach or southern end of the site. It includes the vegetation that borders the three inlets and around the Makapu'u Headland to the lighthouse along the shore bench. The area is characterized by dunes and rock out-croppings. Scaevola taccada Roxb. (beach naupaka) and Messerschmidia argentea (L. f.) Johnston (beach heliotrope) are the dominant plants among the dunes along with some native ground cover such as Lipochaeta integrifolia (Nutt.) Gray (nehe) and Ipomea brasiliensis (L.) Sweet (beach morning glory). Euphorbia degeneri var. degeneri Sherff ('akoko), Boerhavia diffusa Heimerl. ('alena), and the tiny lavender flowered Nama sandwicensis Gray are all native plants found in the strand vegetation zone.

North of the groin at the base of Kapaliokamoa, along the shore bench, the first 8 to 10 m of the cliff face along the shoreline, is barren rock. The next 5 m or so are marked with scattered patches of Dactyloctenium aegyptium (L.) Willd. (beach wire grass). Widely separated flowering plants begin to appear at about 20 m above the sea. Because of the constant wind and salt spray these plants--Prosopis pallida HBK. (kiawe), Leucana leucocephala (Lam.) deWit (koa haole), and Pluchea sp.--are sheared to about 10 cm in height. The layering, in relation to salt tolerance, appears to lessen higher on the cliff face. Opuntia sp. (panini), Pluchea sp. and Prosopis pallida (kiawe), along with the natives Sida fallax L. (ilima) and Jacquemontia sandwichensis Gray (Pa'u-o-Hi'iaka), begin to form a scrub cover higher up, but the constant wind affects all growth forms. Because of the steepness of this face the survey was done with binoculars.

At the inland edge (mauka) of the strand zone, near the Hawaii Kai golf course, there is a large, widely dispersed population of Myoporum sandwicense Gray (naio). Some of these endemic trees attain a height of 4m or more. On the inland side of Ka'ili'ili Bay there is a large, flourishing colony of mangrove trees. This population includes all size classes from seedlings to reproducing trees. The roots of these trees are known to form protective habitat for small fish. The salt tolerant species Sesuvium portulacastrum L. (akulikuli)

and Batis maritima L. (salt bush) form solid mats at the inshore edges of the lagoons. Near the inland edge of the lagoon, near Pu'u o Kipahulu, a population of Thespesia populnea (L.) Soland. ex Correa (milo) is just becoming established. At present the colony consists of several adult trees.

The koa haole basil scrub community extends into the site from the Pu'u o Kipahulu slope and continues westward behind the inlets to Kalaniana'ole Highway. It is a patchy community which affords 0 to 100% scrub cover. The dominant plant, koa haole, seldom attains a height of 2 m and is summer deciduous. The wild basil (Ocimum basilicum) understory is more widespread and somewhat denser than the koa haole. The grass Andropogon aristatus Poir. is found in all parts of this community and in some places it forms solid mats. The spreading, woody endemic Hawaiian cotton, Gossypium sandvicense Parl. (ma'o) manages to compete very well with the alien grasses and shrubs in this and the adjoining GHK (guinea grass-koa haole) community. Hawaiian cotton is summer deciduous, although there were a few plants which still had leaves and a few flowers. When cotton is grown as an ornamental and receives water regularly, it retains its leaves all year around. Another common native plant in this zone is Lipochaeta lobata (Gaud.) DC. This taxon is also found in the GHK and KC communities and probably survives because it sheds its leaves during dry weather.

Along the hillside and on to the Makapu'u Overlook is the related guinea grass-koa haole (GHK) community, with conspicuous kiawe trees. These widely scattered trees often attain a height of 6 m or more. The understory is koa haole which forms a closed cover, and above the Coast Guard road it frequently attains a height of 2.5 m. The coarse grass, Panicum maximum Jacq., (guinea grass) forms the bottom layer of this community.

At the Makapu'u lookout there are small pockets of strand vegetation, but the dominant feature is the rock outcrops. In this area of almost constant wind the vegetation is reduced to such ground hugging taxa as pa'u-o-hi'iaka and nene, both endemic Hawaiian species. The effects of existing drought conditions were most obvious around the lookout. Most of the shrubs and grasses, reported from here in the past, were missing. Only the very drought resistant Lantana camara L. and Opuntia megacantha Salm-Dyck, (tree cactus) were still green.

The fourth major vegetation zone is the KC (kiawe-cotton) lowland. This zone begins just below the Coast Guard road and parallels Kalaniana'ole Highway to

the Hawai'i Kai golf course. The transition from KC to HKB is gradual but clear. This large grass area is dotted with kiawe trees of 5 to 8 m in height. The grass is predominantly Chloris barbata Link. (swollen finger grass) with several other species mixed in. In some parts of this open plain there are dense concentrations of Hawaiian cotton.

In 1971, Karlawinata reported the water fern Marsilea villosa Kaulf. from this part of the study site. Since that time large quantities of fill material have been dumped in the area. After a prolonged search it was concluded that the habitat of Marsilea had been destroyed.

There is no way of knowing exactly what grew in the Queen's Beach study area before the Hawaiians arrived. In 1888, William Hillebrand, the first botanist to spend an extended period studying the Hawaiian flora, wrote, "the lowland zone is open country, grass-covered after the rains, with isolated trees or clumps of trees represented by Hau, Wiliwili, Reynoldsia, Hala, Capparis, cotton and Abutilon and some shoreline species."

Twenty-five years later, Joseph Rock (1913) described the strand vegetation as "scanty" and said it consisted of a "few herbaceous plants and three or four species of trees, which are scattered, single ones here and there on the beaches".

RECOMMENDATIONS

In planning for the future use of the Queen's Beach study area, consideration should be given to preserving fragments of the Hawaiian biota by using shrubs and trees native to the area in landscape or restoration plans, and by setting aside a portion of the strand area for the preservation of some of O'ahu's unique shoreline plants. There is already a concentration of native plants along the shore, just north of the rock and concrete barrier between Wawamalu Beach and the study area. If the area from this barricade to the Kaloko inlet could be kept free of vehicular traffic, the plants already there would survive and flourish. Mauka of Kaloko inlet and Ka'ilili Bay, near the jeep road, there is a large concentration of naio trees. Because of the extensive urbanization of O'ahu, naio trees are more difficult to find at low elevations. These trees are able to survive the hot, dry weather and keep their green leaves. A Hawaiian native plant sanctuary including the naio trees native to Queen's Beach would help save examples of shore plants for the public to enjoy. In addition, many of the

native plants that were lost from this area during the 1946 tsunami could be reintroduced. If protected from automobiles, most of them would require little or no upkeep, since they have evolved to withstand existing conditions.

Other native plants found during this survey could be used in landscaping. For example, Hawaiian cotton was found in most parts of the study area. With minimum irrigation it will grow into a much branched shrub 1 to 2 m in height and produce bright, yellow, hibiscus-like flowers.

In years past the tree Erythrina sandwicensis Degener (Hawaiian Wiliwili) was common to this site. Wiliwili forms a wide, spreading tree 6 to 10 m in height with flowers ranging in color from white to deep red. Seeds for the re-establishment of wiliwili trees at Queen's Beach are readily available from the Koko Crater Botanical Garden (bright orange flowered) or from Kulepiamoa Ridge in Niu Valley (pale salmon colored flowers).

The planting of milo which is already established near the man-made inlet at the base of Kapaliokamoa could be enlarged. Milo trees often reach a height of 12 m or more and make good shade trees. They have been used extensively in the subdivisions in the Hawaii Kai area as street trees.

Two other strand plants found during this survey and worthy of note are 'akoko and nama. A few 'akoko plants are growing on Kaloko Point. Given a chance it grows into a shrub about 1 m in height with bright, red, triangular fruits. It looks like a natural bonsai. It requires little care, but it must be protected from trampling feet. Nama is a delightful little shrub that once grew along the shore line of most Hawaiian Islands. Today it is found at only two locations on O'ahu, Queen's Beach and Barbers' Point Naval Air Station. It is usually less than 2 feet in height and is covered with pinkish-lavender flowers.

Nama and 'akoko, as well as any of those in Table 1 designated E or I (Endemic or indigenous to the Hawaiian Islands), should be planted in the strand vegetation preserve. Many other native plants could be used for landscaping of the site. Even some of those lost to this site during the 1946 tsunami could be re-introduced while parent material is still available. Among these plants is the unusual native Capparis sandwichiana DC. (caper or pua-pilo). Pua-pilo is an evergreen shrub which has very

beautiful, delicate flowers with white petals and a mass of stamens 5 to 6 cm long with yellow tips. The flowers open at night or during the early morning hours when they give off a heavy perfume. There are mature pua-pilo plants near Campbell Industrial Park where seed could be gotten for new plants. Many similar examples could be cited.

Many native plants which could be used in this preservation area if it is to be re-vegetated (Table 2). The growth form which these plants can obtain under ideal conditions is shown on the list. Most of these plants have evolved to thrive under conditions similar to those found at Queen's Beach. They would require only minimum water and care.

One introduced plant, often considered a weed, is kiawe. It is wide spread on this site and some of the trees are already 10 m or more in height. The lower branches of large kiawe could be trimmed and the trees cared for to provide instant shade.

ACKNOWLEDGMENT

I would like to thank my colleague George Linney for assistance both in the field and in the laboratory in identifying plants found during this study.

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Table 1. List of flowering plants found during this survey of the Queen's Beach Area, O'ahu, Hawai'i.

This list is arranged alphabetically by family. The scientific name, the common name, and the status, whether native or introduced, are given for each taxon. (A = Alien; E = Endemic; I = Indigenous; P = Polynesian introduction.)

SCIENTIFIC NAME	COMMON NAME	STATUS
Amaryllidaceae		
<u>Agave americana</u> L.	Century plant	A
Apocynaceae		
<u>Thevetia peruviana</u> (Pers.) K. Schum	Be-Still tree	A
Acanthaceae		
<u>Asystasia gangetica</u> (L.) T.	Chinese Violet	A
<u>Barleria cristata</u> L.	Philippine violet	A
Aizoaceae		
<u>Sesuvium portulacastrum</u> (L.) L.	Akulikuli	I
Amaranthaceae		
<u>Alternanthera repens</u> (L.) Ktze.	Khahi Weed	A
<u>Amaranthus spinosus</u> L.	Spiny amaranth	A
Anacardiaceae		
<u>Schinus terebinthifolius</u> Raddi	Brazilian pepper	A
Asclepiadaceae		
<u>Stapelia nobilis</u> N. E. Br. ex Hook.	Carrion flower	A
Batidaceae		
<u>Batis maritima</u> L.	Akulikuli-kai	A
Boraginaceae		
<u>Heliotropium anomalum</u> var. <u>argenteum</u>	Hina-hina	I
<u>H. curassavicum</u> L.	Hina-hina	I
<u>Messerschmidia argentea</u> (L.f.) Johnston	Tree heliotrope	I
Cactaceae		
<u>Hylocereus undatus</u> (Haw.) Britt. & Rose	Cereus	A
<u>Nopalea cochenillifera</u> Salm-Dyck	Cochineal cactus	A
<u>Opuntia megacantha</u> Salm-Dyck	Panini	A
<u>O. microdasys</u>	No common name	A
<u>Opuntia</u> sp.	Tuna	A
Casuarinaceae		
<u>Casuarina equisetifolia</u> Stickm.	Iron wood	A
Chenopodiaceae		
<u>Atriplex semibaccata</u> R. Br.	Aust. saltbush	A
<u>Chenopodium alba</u> L.	Pig Weed	A
<u>C. carinatum</u> R. Br.	Keeled goose foot	A
Commelinaceae		
<u>Commelina diffusa</u> Brum. f.	Honohono grass	A
Compositae		
<u>Ageratum conyzoides</u> L.	Ageratum	A
<u>Bidens pilosa</u> L.	Spanish needle	A
<u>Emilia javanica</u> (Burm. f.) C. B. Robins	Red pualele	A
<u>Lipochaetia integrifolia</u> (Nutt.) Gray	Nehe	E
<u>L. lobata</u> (Gaud.) DC.	Lobed lipochaeta	E

Table 1. continued.

<u>Pluchea indica</u> (L.) Lees	Indian pluchea	A
<u>P. odorata</u> (L.) Cass.	Pluchea	A
<u>Reichardia picroides</u> (L.) Roth	Picridium	A
<u>Sonchus oleraceus</u> L.	Sow thistle	A
<u>Tridax procumbens</u> L.	Coat buttons	A
<u>Verbesina encelioides</u> (Cav.) B&H ex Gray	Golden crown beard	A
<u>Vernonia cinerea</u> (L.) Less.	Ironweed	A
<u>Wedelia trilobata</u> (L.) Hitchc.	Wedelia	A
<u>Xanthium saccharatum</u> Wallr.	Cocklebur	A
Convolvulaceae		
<u>Cuscuta sandwichiana</u> Choissy	Dodder	E
<u>Ipomoea brasiliensis</u> (L.) Sweet	Pohuehue	I
<u>I. cairica</u> (L.) Sweet	Koali	I
<u>I. congesta</u> R. Br.	Morning glory	A
<u>Jacquemontia sandwichensis</u> Gray	Pa'u-o-hi'i'aka	E
<u>Merremia aegyptia</u> (L.) Urban	Hairy merremia	A
Crassulaceae		
<u>Kalanchoe crenata</u> Haw.	Bryophyllum	A
<u>K. pinnata</u> (Lam.) Pers.	Air plant	A
Cucurbitaceae		
<u>Momordica balsamina</u> L.	Balsam apple	A
Cyperaceae		
<u>Fimbristylis pycnocephala</u> Hbd.	No common name	I
Euphorbiaceae		
<u>Euphorbia degeneri</u> var <u>degeneri</u> Sherff	'Akoko	E
<u>E. glomerifera</u> (Millsp.) L. C. Wheeler	No common name	A
<u>E. hirta</u> L.	Spurge	A
<u>E. lactea</u> Haw.	Mottled candlestick	A
<u>E. prostrata</u> Ait.	Prostrate spurge	A
<u>E. tirucalli</u> L.	Pencil tree	A
<u>Ricinus communis</u> L.	Castor bean	A
Goodeniaceae		
<u>Scaevola taccada</u> Roxb.	Beach naupaka	I
Gramineae		
<u>Andropogon aristatus</u> Poir.	Wilder grass	A
<u>A. pertusus</u> (L.) Willd.	Nose hair grass	A
<u>Brachiaria mutica</u> (Forsk.) Stapf	California grass	A
<u>Cenchrus echinatus</u> L.	Common sandbur	A
<u>Chloris inflata</u> Link.	Swollen fingergrass	A
<u>Cynodon dactylon</u> (L.) Pers.	Bermuda grass	A
<u>Dactyloctenium aegyptium</u> (L.) Willd.	Beach wiregrass	A
<u>Digitaria adscendens</u> (HBK.) Henr.	Henry's crabgrass	A
<u>Eleusine indica</u> (L.) Gaertn.	Goosegrass	A
<u>Panicum maximum</u> Jacq.	Guineagrass	A
<u>Rhynchelytrum repens</u> (Willd.) C. E. Hubb.	Natal redtop	A
<u>Setaria verticillata</u> (L.) Beauv.	Bristly fox tail	A
<u>Sorghum halepense</u> (L.) Pers.	Johnsongrass	A
<u>Sporobolus virginicus</u> (L.) Kunth	Beach dropseed	A
<u>Tricachne insularis</u> (L.) Nees	Sourgrass	A
Hydrophyllaceae		
<u>Nama sandwicensis</u> Gray	Nama	E

Table 1 continued.

<u>Labiatae</u>		
<u>Hyptis pectinata</u> (L.) Poit	Comb hyptis	A
<u>Leonotis leonurus</u> (L.) R. Br.	Lion's tail	A
<u>Ocimum basilicum</u> L.	Wild basil	A
<u>Plectranthus parviflorus</u> Willd.	Spurflower	
<u>Leguminosae</u>		
<u>Acacia farnesiana</u> (L.) Willd.	Klu	A
<u>A. melanoxylon</u> R. Br.	Aust. blackwood	A
<u>Cassia leschenaultiana</u> DC.	Partridge pea	A
<u>Clitoria ternatea</u> L.	Butterfly pea	A
<u>Crotalaria incana</u> L.	Fuzzy rattle-pod	A
<u>C. juncea</u> L.	Sunn hemp.	A
<u>Desmanthus virgatus</u> (L.) Willd.	Virgate mimosa	A
<u>Erythrina</u> sp.	Unknown	A
<u>E. crista-galli</u> L.	Coral tree	A
<u>Indigofera suffruticosa</u> Mill.	Indigo	A
<u>I. tinctoria</u> L.	Indigo	A
<u>Leucaena leucocephala</u> (Lam.) deWit	Koa haole	A
<u>Phaseolus lathyroides</u> L.	Cow pea	A
<u>Prosopis pallida</u> HBK.	Kiawe	A
<u>Liliaceae</u>		
<u>Aloe arborescens</u> Mill.	Tree aloe	A
<u>A. vera</u> L.	Aloe	A
<u>Aloe</u> sp.	Aloe	A
<u>Sansevieria trifasciata</u> Prain	Bowstring hemp.	A
<u>Malvaceae</u>		
<u>Abutilon molle</u> Sweet	Hairy abutilon	A
<u>Gossypium</u> sp.	Cotton	A
<u>G. sandwicense</u> Parl.	Ma'o	N
<u>Malvastrum coromandelianum</u> (L.) Garcke	False marrow	A
<u>Sida fallax</u> Walp.	'Ilima	I
<u>Sida</u> sp.	Unknown	?
<u>Thespesia populnea</u> (L.) Soland.ex Correa	Milo	P
<u>Myoporaceae</u>		
<u>Myoporum sandwicense</u> Gray	Naio	E
<u>Nyctaginaceae</u>		
<u>Boerhavia diffusa</u> Heimerl.	Alena	I
<u>Onagraceae</u>		
<u>Ludwigia octovalvis</u> (Jacq.) Raven	Primerose willow	A
<u>Palmae</u>		
<u>Cocos nucifera</u> L.	Coconut	P
<u>Passifloraceae</u>		
<u>Passiflora foetida</u> L.	Love-in-a-mist	A
<u>Polygonaceae</u>		
<u>Antigonon leptopus</u> H. & A.	Mexican creeper	A
<u>Portulacaceae</u>		
<u>Portulaca cyanosperma</u> Egler	Ihi	E
<u>P. oleracea</u> L.	Pig weed	A
<u>Rhizophoraceae</u>		
<u>Rhizophora mangle</u> L.	Mangrove	A

3

Table 1 continued.

<u>Solanaceae</u>		
<u>Lycopersicon esculentum</u> Mill.	Tomato	A
<u>Nicotiana glauca</u> Grah.	Flowering tobacco	A
<u>Solanum nigrum</u> L.	Popolo berry	?
<u>Sterculiaceae</u>		
<u>Waltheria americana</u> L.	Hi'aloa	P
<u>Verbenaceae</u>		
<u>Lantana camara</u> L.	Lantana	A
<u>Stachytarpheta jamaicensis</u> Vahl	Jamaica vervain	A
<u>Zygophyllaceae</u>		
<u>Tribulus cistoides</u> L.	Nohu	A

Table 2. Native Plants Suggested for Planting at the Queen's Beach Area.

<u>Plant</u>	<u>Common Name</u>	<u>Growth Form</u>
<u>Canthium odoratum</u>	Alahe'e	Tree
<u>Sesbania tomentosa</u>	Oahu sesbania	Shrub
<u>Gossypium sandwicense</u>	Ma'o	Shrub
<u>Brighamia insignis</u>	Alula	Tree
<u>Lipochaeta lobata</u>	Lobed lipochaeta	Shrub
<u>L. integrifolia</u>	Nehe	Herb
<u>Myoporum sandwicense</u>	Naio	Tree
<u>Sapindus oahuensis</u>	Aulu	Tree
<u>Santalum ellipticum</u>	Sandalwood	Tree
<u>Messerschmidia argentea</u>	Tree heliotrope	Tree
<u>Erythrina sandwicensis</u>	Wili Wili tree	Tree
<u>Scaevola taccada</u>	Beach naupaka	Shrub
<u>S. coriacea</u>	Naupaka	Herb
<u>Cordia subcordata</u>	Kou	Tree
<u>Calophyllum inophyllum</u>	Kamani*	Tree
<u>Vitex ovata</u>	Pohinahina	Shrub
<u>Capparis sandwichiana</u>	Pua pilo	Shrub
<u>Abutilon menziesii</u>	Ko'olua'ula	Shrub
<u>Hibiscus tiliaceus</u>	Hau	Tree
<u>Thespesia populnea</u>	Milo*	Tree
<u>Pandanus</u>	Hala	Tree
<u>Pritchardia remota</u>	Lo'ulu	Tree
<u>Reynoldsia</u> sp.	'ohe'ohe makai	Tree
<u>Nama sandwicensis</u>	Nama	Herb
<u>Euphorbia degeneri</u>	'Akoko	Shrub

*Thespesia populnea or milo and Calophyllum inophyllum or kamani are Polynesian introductions. Although not native plants, they are pan-tropical, wind, and salt-tolerant.

SELECTED RESEARCH AND
EDUCATIONAL INSTITUTIONS OF SOUTH CHINA
22 DECEMBER 1984 - 23 JANUARY 1985

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I. South China Institute of Tropical Botany and Environs

On Dec. 22, 1984 we travelled from Honolulu to Hong Kong (transit) and then to Guangzhou. We were met by Professor Guo, South China Institute of Botany, and Mrs. Tseng, Guangzhou office of *Academica Sinica* and made a brief afternoon tour of the botanic gardens within the city parks. Special exhibits on ornamental horticulture were dramatic, particularly the training of chrysanthemums.

The next day we departed Guangzhou for Kunming where we were met by Mr. Pei and the local *Academica Sinica* representative, Mr. Wang. Local tours were made of the Temple of Eighteen Buddhas, Lake Yunnan, Copper Temple and Black Dragon Pool. At Lake Yunnan during the Cultural Revolution, much of the Lake was filled-in for new agricultural land; although work on land-fill has stopped, excellent use of the land bridge has created a highly scenic area supporting both agriculture and tourism. The Copper Temple flora included: Magnolia, Hibiscus, Rhododendron, Cupressus, Juniperus, Ketelaria, and Musa nana. There were also many plants pot-cultivated for hundreds of years. The most striking were the Prunus mumi tree planted in the Ming Dynasty of the 13th century; at the Black Dragon Pool a Cupressus from the Sung Dynasty of the 9th century was growing, a Cryptomeria of similar age, and a Prunus from T'ang Dynasty over 2000 years old.

Next we took a domestic flight from Kunming to Sumao in Southwest Yunnan, and flew 90 minutes over 2000-3000 meter high mountains and paddy-filled river valleys. The views from a relatively small plane at 5000 meters was dramatic. In Sumao we were met by Pei's driver, Mr. Sen, and a six hours winding mountain road journey began. We arrived at The Institute of Tropical Botany on Christmas day. A special corner of the dining hall was decorated with a Hibiscus rosa-sinensis in lieu of a Christmas conifer!

The Institute of Tropical Botany

1. Description of General Environment:

The institute in Xishuangbanna Prefecture (21½ 41' N, 101½ 25' E) is part of the Academia Sinica. It was founded in 1959 and now has 266 developed hectares (out of 1000 total); a library of 30,000 volumes (1000 periodical titles); a garden/herbarium collection of 60,000 specimens including 2500 native and introduced species; 1000m² of special gardens; 3000m² of laboratory facilities and 13 special ecological communities and living collections.

The Institute is situated at 600m elevation on the Luosuo River--a Mekong River tributary. It lies amidst a range of hills and low mountains rising to about 2000m. There exists a rich diversity in vegetation but is not characterized by one or a few upper story dominants. The mix is so complex that it typically includes species of Caesalpinaceae (Cassia, Albizzia); Euphorbiaceae (Antidesma, Phyllanthus); Fagaceae (Fagus); Lauraceae (Laurus, Cinnamomum); Moraceae (Artocarpus, Ficus); Rubiaceae (Anthocephalus, Saprosma) Sonneratiaceae (Duabanga); and Theaceae (Camellia).

The area is limestone based with a relatively thick layer of latisol allowing for the establishment of deep-rooted species. The soil pH is typically 6.5-7.0.

The region features a Karst topography characteristic of heavily eroded limestones. Its considerable geologic age is also suggested by the marked meanders of the Luosuo River and the flat flood plain profile. Xishuangbanna (at ca. 600m) in general has a winter dry season with low temperatures of 12-15½ and highs of 20-23½. Commonly winter night temperatures fall below the dew point, producing dense nightly ground fogs. The summer rainy season extends from April to October and high temperatures of 28-32½ are common with a mean annual temperature of 21.6½C. Annual rainfall reaches 1400-1600 mm. High winds are not common, but air drainage from the Tibetan Plateau (>3000 m) can occasionally produce cold injury in the sensitive species especially rubber (Hevea) trees. Solar radiation reaches 130 kcal/cm² at ground level.

From a comparative point of view both Xishuangbanna and Hawai'i are at similar latitudes and have cool upland tropical forests. A number of common genera are shared by both locales: Acacia, Acalypha, Albizzia, Antidesma, Artocarpus, Arundina, Blechnum, Bulbostylis, Canavalia,

Cassia, Casuarina, Cibotium, Coix, Cyperus, Davallia, Dodonaea, Eucalyptus, Eugenia, Ficus, Hedyotis, Hibiscus, Ixora, Jatropha, Leucaena, Mangifera, Metrosideros, Morinda, Mucuna, Nephrolepis, Pandanus, Paspalum, Passiflora, Pluchea, Psidium, Psychotria, Saccharum, Samanea, Santalum, Schinus, Sesbania, Sophora, Wedelia, Vaccinium. Included in this list are genera introduced into China (e.g. Metrosideros lutea from New Zealand) and cosmopolitan genera (e.g. Acacia, Cyperus, Vaccinium), but all these families thrive in both locations.

Six hundred meters higher, the evergreen mountain flora are well established in Xishuangbanna. The limiting factor is winter temperature with low values of 11-12°C and highs of 23-25°C. The tropical genera listed disappear in the main, although some tropical species are still abundant. The canopy and higher understory are dominated by a diverse group of species from the genera: Acer, Actinodaphne, Betula, Castanea, Castanopsis, Cinnamomum, Elaeocarpus, Fagus, Lindera, Litsea, Phoebe, Quercus. The evergreen forest is obviously a subtropical transition zone. At these elevations, many familiar temperate zone trees flourish receiving occasional winter subzero temperatures. With additional elevations, the subtropical temperature transition ends and the woody dominants are replaced by pines (Pinus spp.).

Ethnographically, Yunnan Province and especially, Xishuangbanna Prefecture, is an area of high diversity. In addition to the Han Chinese there are many minority people related to the Thais, known here as Dai. Other important ethnic minorities include the Bulang, Hani, Yi, Wa, and Chinese Moslems known as Hui. The Hani are of Tibetan origin. Refugee settlements have also been established for people from Laos and Cambodia.

The Institute itself functions as a village with a population of about 1300 with 300 as the scientific and technical staff, of which about 100 have university degrees. The Institute maintains a public library, a general store, community center-cinema, a barber, five doctors and a small hydroelectric station. Professor Pei is both director of the Institute in its scientific endeavors, and also chief administrator of the entire Han-Dai community. The Chinese doctors were all western trained in medical colleges founded predominantly by French missionaries. Medical services are free to all staff, and available to Dai villagers for a fee. The Dai have their own practitioners, but are turning increasingly to the Chinese physicians.

2. Analytic Facilities and Research:

The Institute's Analytical Laboratory is well equipped for phytochemical research. Instrumentation includes a Waters 2-detector High Pressure Liquid Chromatograph; Shimadzu Thin-Layer Chromatography Densitometer system; Perkin-Elmer Grating Infra-Red Spectrophotometer; Hitachi UV-Visible Double Beam Spectrophotometer; Chromatron GC with electron-capture and flame-ionization detectors; and a Carlo Erba Element Analyzer. This facility is not yet fully staffed with experienced analysts and has maintenance and service problems by virtue of geography.

The resources of the Analytic Laboratory have been applied successfully to such problems as:

- (a) isolation and characterization of the anti-tumor (C-mitotic) compounds of Maytenus hookeri Loes and other Maytenus spp. The Maytenus principle is a mixture of N-acyl derivatives of a macrocyclic C_{21} compound containing both a chlorophenyl moiety and conjugated diene system.
- (b) studies of the physico-chemical constants and properties of seed oils from 120 species (39 families) of tropical and sub-tropical plants at the institute. Saponification and unsaturation data of these oils will aid in identifying their potentials for food and industrial applications.
- (c) identification of the medicinal materials in Dracaena cambodiana (Agavaceae)
- (d) identification of abscissic acid as the dormancy regulator in seeds of Anthocephalus chinensis, one of the more interesting fast-growing tree species selected for special study.

The preliminary screening of candidate seeds for in-depth chemical characterization of lipids takes place in the Oil and Fat Laboratory. In addition to the major efforts at physico-chemical analysis mentioned above, some specific accomplishments of this facility and program include:

- (a) discovery in Horsefeldia glabra (Myristicaceae) of a lipid fraction that if added to conventional motor oils, lowers their freezing or gel points by several degrees C.
- (b) discovery in Jatropha curcas (Euphorbiaceae) of an unsaturated C_{18} fatty acid directly usable as a fuel in diesel engines.

- (c) discovery of the high edible oil content in rubber, Hevea brasiliensis, seeds. This is of major importance because mature Hevea rubber trees yield far more seed than are needed for plantation maintenance. China, with 500,000 hectares of rubber plantation is the world's 4th largest producer of latex.
- (d) discovery of the edible oil and fruit of Hodgsonia macrocarpa (Cucurbitaceae) as a food source.

3. The Library:

A visit to the library provided an impressive list of reference and periodical titles, including: Analytical Biochemistry, Biological Abstracts, Biochemical Journal, Chemical Abstracts, Canadian Journal of Biochemistry, Cancer Therapy, Chemical Titles, Chemical and Engineering News, Ecological Monographs, Economic Botany, Excerpta Medica (Pharmacology and Toxicology), Forestry Abstracts, Genetics Abstracts, Index Chemicus, Journal of Agricultural Science, Nature, Plant Physiology, Science, and many more familiar English language sources. Special references include publications of L. H. Bailey, Degener's Flora Hawaiiensis and a complete set of Sadtler's Infra-Red Spectra. There are, of course, Chinese language works and some Russian publications, including Doklady Nauk.

4. The Herbarium:

The herbarium is far from ideally set up with respect to environmental control, but is well organized and very actively used by many of the staff. One noteworthy point is that by policy, paradichlorobenzene is not used to protect the collection against insects because it is considered unsafe for human exposure. Instead, generous use is made of camphor, imparting a pleasant odor to the herbarium. Aside from the reduced human hazard, the advantage is that camphor is produced commercially in Xishuangbanna, whereas paradichlorobenzene must be imported.

This herbarium forms the basis for identification of tropical species in Yunnan Province (there are 20 recognized type specimens in the collection) and is especially important as an ethnobotanical source for the most important and useful plants among the ethnic minorities of Xishuangbanna. This special group includes 218 species of 187 genera of 90 families. Seed plants

are classified according to Hutchinson; ferns are classified following Qing Renschang, however, modern Chinese systematists generally favor the Englerian classification scheme.

5. Tree Research:

In addition to rubber (Hevea) and fruit crops, economic forestry has focused on fast-growing tree species, especially those with the potential for multiple usage. Mr. Zhou Shouqing discussed the tree Anthocephalus chinensis, (Rubiaceae), which in 10 years grows an average of 24 meters in height with a circumference of about 1.4 meters. Other comparable candidates include high density Albizzia species (A. odoratissima, A. procera and A. falcataria), Acrocarpus fraxinifolius (all Mimosaceae) and Duabanga grandiflora (Sonneratiaceae). Mr. Zhou's own research, include Dracontomelon macrocarpum (Anacardiaceae) and Ochroma lagopus, as well.

The Dracontomelon is a fast growing tree of especial interest because its seed oil content is 69% and fully edible. During its first five years Dracontomelon grows 1-2 meters in height and up to 6cm in diameter annually. At lumbering age (20 years), stocking can reach 310 cu.m./hectare with a mean increment of about 15 cu.m./ha/yr.

The highest yielding strain of Ochroma, the source of familiar balsa wood came from Cuba and has now been successfully introduced into Xishuangbanna. Mr. Zhou also described research which has identified 73 of over 100 species of tropical trees used by ethnic minorities in Xishuangbanna.

6. Tissue Culture:

Tissue culture resources and facilities are severely limited at present, although more support of germplasm propagation and cloning are planned. Ms. Chang Zhei Ying discussed her progress in culturing and maintaining their current stock of 20 species including Aristolochia and Orchidaceae, especially the vanilla bean (Vanilla puerrei).

7. Plant and Cell Structured Studies:

Ms. Zuo and Mr. Wu described two aspects of the program in histology and cytology. It was surprising to learn of the decided interest in leaf anatomy in

Cinnamomum porrectum (Lauraceae) a native spice tree. A microscopic study of leaf cross-sections, however, revealed essential oil rich palisade cells, both upper and lower, but especially upper. Oil bodies were absent from mesophylls guard cells, epidermis and vascular parenchyma.

Another basis for work in leaf anatomy is the use of calcium oxalate crystal aggregates for differentiation of the several Maytenus sp. (Celastraceae).

The cytogenetics of Solanum spp. is of interest from the evolutionary viewpoint, but work on the genus is also stimulated by practical considerations -- i.e., as a possible food resource. Young shoots of S. spirale, a tetraploid, are edible, as are the fruits of diploid S. coagulans.

Sex inheritance in Rumex spp. is also being investigated, especially a newly isolated bisexual triploid strain. Normally Rumex species follow the xy sex determination pattern.

The Seed Laboratory

In addition to routine screening of seeds and viability testing, Mr. Chang studies dormancy in seeds of economic importance. Currently, attention is directed to the fast-growing tree species, Anthocephalus. Its seeds normally germinate only after wet storage at 4-5°C for 2 months. Absciscic acid (ABA) has been found in dormant seeds and appears to decrease during cold storage. Furthermore, dormant seeds do germinate to some extent when treated with gibberellic acid (GA). The working hypothesis is that dormancy is controlled by the ABA-GA ratio.

Dormancy in the Palm, Caryota ochranda has been tentatively linked with an inhibitor, yet to be isolated, of the endosperm oil. Previously, studies on maintenance of seed viability in storage, specially important in the tropics, were also pursued actively. At present, no qualified staff member is available to continue this work.

The Institute Botanic Garden is headed by Ms. Zhang Yuying, who recently returned from a 3-month work/study visit at the Fairchild Gardens, Florida. Aside from its purely aesthetic appeal, which is considerable, this garden provides a living repository of reference material for taxonomic, ethnopharmacological and economic uses. Among its special collections are more than 100 species

of bamboo and a medicinal section of 90 species including species of Hydnocarpus used to treat leprosy; Strophanthus a steroid source; Maytenus, an anti-tumor plant, Eugenia, Syzygium and Rauwolfia used against anxiety, etc. Within the valuable timber trees of the family Dipterocarpaceae, all seven species of Dipterocarpus are maintained in the garden as well as about 100 species of Palmae, one of Mr. Pei's specialties.

8. Tropical Multistory, Multispecific Artificial Communities:

Hevea and Hevea plantations are important to China, and a total of 500,000 hectares, all in the tropical and sub-tropical locations are sited below 900m elevation. In Xishuangbanna alone 50,000ha of Hevea plantation, about 3% of the total area produce 18,000 tons of rubber annually. Traditional plantations are kept clear of other vegetation--in effect taking the land out of use (other than for rubber). Against this reality, the Institute in a 50-hectare experiment in agro-ecology has selected productive herbaceous plants, shrubs and low trees for testing as components of Hevea tree community sub-stories. In the 2-species associations, a common second cover story was provided by Maytenus spp. (medicinal), Rauwolfia yunnanensis (medicinal), Thea sinensis var. assamica (tea), Coffea arabica (coffee), or Cinchona ledgeriana (medicinal); all these were shrubs or low trees.

These understory economic plants are benefited by the shade. For green teas, a shade effect of up to 50% is achieved without loss of quality. For black teas, however, more direct sunlight is essential. Other lower story plants in the rubber plantations include Cassia siamea, used by the Dai people for firewood since the 15th Century. This tree reaches one-half to two-thirds the height of Hevea. Other lower understory test species include Amomum villosum (Zingiberaceae), Homalium laoticum (Samydaceae), Baccaurea ramiflora (Euphorbiaceae) and others.

A variety of arrays are being compared such as Hevea alternating with 1-4 rows of Thea, clusters instead of rows of mixed species, and 3 species Hevea community with Rauwolfia and Amomum.

The advantages of such multistory mixed communities are water conservation, erosion control and maintenance of higher nutrient levels.

Other candidates as upper story species are the teak tectona (Verbenaceae) and Terminalia (Combretaceae), both timber trees.

Inclusion of Cassia helps maintain soil nitrogen. The combination of Hevea and Thea may benefit the latter by increasing the number of spiders preying on Thea insects (90 species of Arachnids have been identified on Hevea) and so cut down on insect damage.

Radiant energy, temperature, precipitation and other microclimatic factors are being closely monitored.

A novel variation on the multistory concept involving the time factor involves Anthocephalus chinensis, a timber tree that grows 25 meters in 10 years (harvest maturity, 10th year). During the first year the tree is planted with upland rice. The second year corn is grown among the trees. During the final 3-10 years the tree is grown alone to harvest. The series can be repeated after each 10-year harvest of the commercial lumber.

In nearby uplands, heavily terraced hillsides are alternately planted with Hevea and Crotalaria; the maintenance of the soil nitrogen level is thus guaranteed by the nitrogen fixing capabilities of the legume.

9. Mountain Soils Reclamation Project:

Three species are being compared as green manure. Performance to date shows in 2-3 years the following:

Leucaena leucocephala (Mimosaceae) fresh weight yield 22.5 tons/hectare

Butea monosperma (Caesalpinaceae) fresh weight yield 45 tons/hectare

Moghania macrophylla (Papilionaceae) fresh weight yield 34 tons/hectare

10. Science, Religion, and Minority People:

In this foothill and low mountain country, the Dai village tradition recognizes as sacred certain forested hills. About one out of three hills is so designated, hence not to be subject to any sort of cultivation, harvest or other disturbance to its natural integrity. This tradition may be construed as conservation by religious injunction. We are told that it has been a

successful part of the minority people's conservation practice for 500 years. The limestone forest lies along the upper slopes of the youthful Menshing River Valley. It is so called because the otherwise reddish-brown clay soil is littered with a calcite and highly ubiquitous crystalline outcrops. The canopy consists of Ficus altissima, Tetrameris sp. and Duabanga grandiflora (Sonneratiaceae).

A middle story consists mainly of Cassia siamea with various bamboos. A lower story contains Eupatorium (Compositae), Capsicum, Eugenia, Acacia, Solanum, Ricinus and Hibiscus together with Colocasia (taro) and Musa (banana) in wetter places. A relatively rich assortment of ferns including Adiantum, Dryopteris, Nephrolepis, Pteridium (edible species), Pteris, plus Selaginella provide ground cover.

We were privileged with a visit to a Dai village for the celebration of the Spring Water festival which coincides approximately with western New Year; and provides the village with an opportunity to be hospitable to foreign visitors. A number of Dai dishes were offered for the occasion in one of the massive wooden polehouses. These were tasted rather than consumed as they were all in varying states of fermentation or prepared with hot pepper. An exception was stick rice (rice baked inside hollow aromatic bamboo stems). As honored guests we were taken to the village center where we were covered with water by some of the young women of the village. Later we were allowed to sprinkle the people of the village with the remaining water. Two men performed the traditional dance of the peacock for the event and an "orchestra" of local drums and string instruments accompanied them. Most of the 30 families of the village attended and ritual singing and dancing completed the visit. The friendly village headman is also the local administrator appointed to manage the Laotian and Cambodian refugee villages nearby.

11. Orchids and Shade Plants and Tropical Fruits and Trees:

These units are primarily devoted to practical matters of cultivation and maintenance of species, hence are for research support rather than research *per se*. From the inflorescence of Bulbophyllum with 5mm flowers to the 12cm flowers of Phaius, the Orchid collection was impressive even though most plants were not in flower. We saw the following genera: Acrides, Cattleya, Cymbidium, Coelogyne, Dendrobium, Eria, Goodyera,

Holcoglossum, Paphiopedilum, Vanda, and Vandopsis. The fern collection housed here included Adiantum, Platycerium, Dryopteris, Humata (Davalliaceae), Phlegmarioris (Huperziaceae), Pseudodrynaria. The walls of the shade house were covered with a tangle of densely leafed Thunbergia vines profuse with orange flowers.

Many introduced fruit trees and economic plants are being studied for their suitability to the soil and climate of Yunnan. Both new and old world species are included from Mexico, South America and S. E. Asia.

Casimirosa (Ritaceae) from S. America is valued for its fruit as are several Sapotaceous fruit trees from South America or Mexico - Manilkara, Lucuma and Synsepalum, for example.

From the Sapindaceae, two representatives were present -- Litchi and Nephelium (Rambutan).

Other fruit trees included the genera:

Soursop	<u>Anona</u>	(Anonaceae)
Jackfruit	<u>Artocarpus</u>	(Moraceae)
Carambala	<u>Averroa</u>	(Oxalidaceae)
Papaya	<u>Carica</u>	(Caricaceae)
Pomelo	<u>Citrus</u>	(Rutaceae)
Persimmon	<u>Diospyros</u>	(Ebenaceae)
Mango	<u>Mangifera</u>	(Anacardiaceae)
Avocado	<u>Persea</u>	(Lauraceae)
Cacao	<u>Theobroma</u>	(Sterculiaceae)

12. Finale:

A sumptuous "banquet" attended by Pei and his senior colleagues ended the last evening at the Institute. The food in this region included cooked green papaya (stuffed), other vegetable dishes included lettuce stems, peanuts, cabbages and mustards. Meat was largely pork, but beef and fish, as well as dog' was available. Spices were used extensively, especially black pepper. Although rice was a staple, steamed breads and noodles often formed the basis of a breakfast--along with fried eggs and pickles.

Part II of this trip report will be published in the next issue of the Newsletter.

Some Faculty Publication lists for 1984-1985

Faculty were asked to submit publication lists for 1984 and 1985 in three categories: published, in press, and submitted. The following faculty responded; others may respond for the next issue.

Isabella A. Abbott

- 1984 Limu, an ethnobotanical study of some Hawaiian seaweeds, 3rd edition. Pac. Trop. Bot. Gard., 35 pp.

Dotyella irregularis sp. nov. and new observations on Cottoniella (Sarcomenioidae, Rhodophyta). Phycologia 23: 369-375.

Two new species of Liagora (Nemaliales, Rhodophyta) and notes on Liagora farinosa Lamouroux. Am. J. Bot. 71: 1015-1022.

Peleophycus multiprocarpium gen. et sp. nov. (Gloiosiphoniaceae, Rhodophyta). Pac. Sci. 38: 324-332.

In Press

- 1985 _____ and J. N. Norris (eds.). Taxonomy of Economic Seaweeds with reference to some Pacific and Caribbean species. Calif. Sea Grant Program, La Jolla, Calif.

_____. Introduction.

_____ and B. Santelices. Gelidium rex sp. nov. (Gelidiales, Rhodophyta) from central Chile.

_____. Gracilaria from Hawaii: Key, list and distribution of species.

_____. Gracilaria from the Philippines: Key and list of the species.

_____. Gracilaria from California: Key, list and distribution of the species.

_____. New species of Gracilaria (Gracilariaceae, Rhodophyta) from California and Hawaii.

_____ and Xia Bangmei. The genus Polycavernosa Chang et Xia (Gracilariaceae, Rhodophyta): A comparison with Gracilaria Grev. and Key to the species.

- 1985 _____ and B. Santelices. Marine algae of Easter Island, Eastern Polynesia. Proc. 5th International Coral Reef Congress.
- 1985 Tsuda, R. and I. A. Abbott. Chapter 4, Collection, handling, preservation, and logistics in: M. M. Littler and D. S. Littler, eds., Handbook of phycological methods: ecological methods for macroalgae. Cambridge University Press, Cambridge.

Submitted

Vegetative and Reproductive Morphology in two new species of Naccariaceae (Rhodophyta). Journal of Phycology.

_____ and C. Shimazu. The geographic origin of the plants most commonly used for medicine by Hawaiians. J. Ethnopharmacology.

Maxwell S. Doty

In Press

- 1985 Eucheuma alvarezii, sp. nov., (Gigartinales, Rhodophyta) from Malaysia. in Abbott, I. and J. N. Norris (eds.) Taxonomy of Economic Seaweeds...

_____ and James N. Norris. Eucheuma species (Solieriaceae, Rhodophyta) that are major sources of carrageenan, in: Abbott, I. and J. N. Norris (eds.) Taxonomy of Economic Seaweeds...

Moss, James R. and M. S. Doty. Hawaii's Prospects as a Site for Algal Hydrocolloid Processing. Hawaii State Department of Land and Natural Resources.

Estimating Gracilaria and Eucheuma farmer returns from line farming. Monographias Biologicas.

Submitted

_____. Eucheuma, A Case Study for the wild Harvest and or Culture of the Seaweed Eucheuma in the Philippines. FAO Miscellaneous Papers.

Santos, G. A. and _____. The natural products of seaweeds from the Hawaiian Point of View. Hawaii Botanical Science paper.

_____ and B. Santelices. Closing Remarks on the Second Chilean National Seaweed Symposium.

Douglas J. C. Friend

- 1984 The interaction of photosynthesis and photoperiodism in induction. pp. 257-275 in: D. Vince-Prue, ed. Light and the Flowering Process. Academic Press.

Shade adaptation of photosynthesis in Coffee arabica. Photosynthesis Research 5: 325-334.

_____, Monique Bodson and Georges Bernier. Promotion of flowering in Brassica campestris L. cv Ceres by sucrose. Plant Physiol. 75: 1085-1089.

In Press

Brassica. 20 pp in: A. H. Halevy, ed. CRC Handbook of Flowering, Vol. 2.

Dieter Mueller-Dombois

- 1984 Classification of plant communities: a review with emphasis on tropical vegetation. Chap. 2 pp. 21-88: in: The role of Terrestrial Vegetation in the Global Carbon Cycle: Measurement by Remote Sensing. SCOPE book ed. by G. M. Woodwell. John Wiley & Sons, Ltd.

Zum Baumgruppensterben in pazifischen Inselwaldern. Phytocoenologia 12(1): 1-8.

_____, P. M. Vitousek and K. W. Bridges. 1984. Canopy dieback and ecosystem processes in Pacific forests: a progress report and research proposal. Hawaii Bot. Sci. Paper No. 44. 100 p.

Burton, P. J. and D. Mueller-Dombois. 1984. Response of Metrosideros polymorpha seedlings to experimental canopy opening. Ecology 65(3): 779-791.

Scale as an investigative tool in the etiology of canopy dieback. Abstract. Bull. Ecol. Soc. of America 65(2): 111.

In Press

- 1985 The biological resource value of native forest in Hawaii, with special reference to the tropical lowland rainforest at Kalapana. 'Elepaio (J. of Hawaii Audubon Soc.) 45(10): 95-161.

'Ohi'a dieback and protection management of the Hawaiian rainforest. Symp. on Protection and Management of Terrestrial Hawaiian Ecosystem. J. M. Scott and C. P. Howe, eds. Hawaii Univ. Press.

Volcanic effects in the Hawaiian rainforest ecosystem. Second Symp. on Island Ecology, Puerto Rico. H. L. Lugo, ed.

'Ohi'a dieback; 1984 synthesis and evaluation. Pacific Science (June 85 issue).

Key elements for site description: vegetation analysis for TSBF and TME programs. Handbook for "Decade of the Tropics" Intern. Research Program, IUBS (International Union of biol. Sciences).

S. M. Siegel

- 1984 Clark, Katherine, S. Siegel and B. Siegel. Bio-corrosion: a note on fungal solubilization of iron from stainless steels. Water, Air, & Soil Pollution 21(1-4): 435-437.

Chang, Healani, B. Z. Siegel, and S. M. Siegel. Salinity-induced changes in the isoperoxidases of Taro, Colocasia esculenta. Phytochemistry 23(2): 233-235.

Galun, M., P. Keller, D. Malki, H. Feldstein, E. Galun, S. Siegel and B. Siegel. Removal of Uranium (VI) from Solution by Fungal Biomass: Inhibition by Iron. Water, Air, and Soil Pollution 21(1-4): 411-414.

Siegel, B. Z., S. M. siegel, T. Speitel, J. Waber and R. Stoecker. Brine Organisms and the Question of Habitat-Specific Adaptation. Origins of Life 14: 757-770.

Siegel, B., M. Lasconia, E. Yaeger and S. Siegel. The Phytotoxicity of mercury vapor: some developmental aspects. Water, Air, & Soil Pollution 23: 24-25.

Siegel, B., S. Siegel, and S. Horsky. Equisetum Plants and the cycling of mercury at Mount St. Helens. Environmental Science and Technology 18(3): 179-181.

Siegel, S. M. and B. Z. Siegel. Annual mercury flux at the Kilauea main vent--a first estimate. Nature 309(5964): 146-147.

Siegel, S. M. and B. Z. Siegel. Regional differences in plant-soil mercury relations in Equisetum, Plantago and Taraxacum. Org. Geochem. 5(4): 255-257.

- 1985 Siegel, S. M. and B. Z. Siegel. Differential elimination of mercury during maturation of leguminous seeds. Phytochemistry 24(2): 235-236.

In Press

Siegel, B. Z. and S. M. Siegel. The Role of Vegetation in the Recycling and Redistribution of Volcanic Mercury: in Bilderback, J. (ed.) "Biological Effects of Mt. St. Helens Eruption", American Association for the Advancement of Science. Washington. (June 1985)

Siegel, S., B. Siegel, C. Lipp, A. Kruckeberg, G. Towers, and H. Warren. Indicator Plant-Soil Mercury Patterns in a Mercury-Rich Mining Area of British Columbia. Water, Air, and Soil Pollution.

Siegel, B. Z. and S. Siegel. Mercury in human hair: uncertainties in the meaning and significance of "unexposed and exposed" sample population. Water, Air, and Soil Pollution.

Siegel, S., P. Keller, M. Galun, H. Lehr, B. Siegel, and E. Galun. Biosorption of lead and chromium by Penicillium preparations. Water, Air, and Soil Pollution.

Siegel, S. M., B. Z. Siegel, LeeAnn Sheldon, Elizabeth Yaeger, and Darwin Chang. Mercury antagonists: Protection of plants against vapor injury by thiamine and other sulfur and selenium compounds. Water, Air, and Soil Pollution.

Siegel, B. and S. Siegel. Equisetum and the cycling of mercury at Mount St. Helens: Plant-soil relations, 1980-84. Water, Air, and Soil Pollution.

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George J. Wong

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FRIENDS OF FOSTER GARDENS Outer Island and Foreign Trips

NEW ZEALAND October 4 - November 4 (Trip 85-7)

Thirty-one days: both North and South Islands, drive our own vans. Trip features frequent two-night layovers so we can hike the trails in the native forest. For information contact Jeanne Potter at: Ask Mr. Foster (526-0633).

HAWAII November 28 - December 1 (Trip 85-8)

Thanksgiving somewhere high above the clouds; alpine zone hiking, tents and warm sleeping bags. Informational meeting: Wednesday September 18 at 7:30 p.m. in the Foster Garden Classroom.

HAWAII December 27 - 30 (Trip 85-9)

From a base in Hawi we will explore historic and natural areas of Kohala (Pololu Valley, Kupohou Ridge, Lopakahi site, Kehena Ditch trail (pending permission). Informational meeting: Wednesday November 20, 1985 at 7:30 p.m. in the Foster Garden Classroom.

These trips explore places and scenes not offered elsewhere with kama'aina naturalist, Loren T. Gill. All trips are designed for the adventurous, the interested islander, nature lovers and the botanically minded.

NEWSLETTER
HAWAIIAN BOTANICAL SOCIETY
C/O DEPARTMENT OF BOTANY
UNIVERSITY OF HAWAII AT MANOA
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Newsletter

Hawaiian Botanical Society



Volume 25 (1)

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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

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SPECIAL ANNOUNCEMENT

At the February meeting of the Hawaiian Botanical Society, the By-laws will be discussed. One issue that will be discussed is the term of the various officers of the Society. It has been suggested that the President and Vice-President should be allowed to serve for more than one consecutive year. If so, should there be a limit on their term in office?

COCCINIA GRANDIS (L.) VOIGT:

A new cucurbitaceous weed in Hawai'i

For several years, I have observed a vine completely enshrouding koa haole plants at the back of the UH Manoa campus, but have not been able to find it in the local herbaria or literature. In the spring of 1985, Cliff Smith collected it in Keolu Hills, Kailua. A more energetic search still failed to produce any record of it. Finally, in the summer of 1985, a chance mention of it to Dick Hamilton, formerly of UH Horticulture Dept., produced a name. He knew it from S.E. Asia. After verifying the identity, it was clear that this plant was previously unreported, and apparently uncollected from Hawai'i. This is more surprising as the plant was (first?) introduced into Hawaii by Don Anderson in 1969. He had found the plant naturalized in Fiji, and thought it suitable for cultivation, as in hanging baskets. The seeds were sent to Lyon Arboretum, under accession number L69.296, and seedlings shared with Foster Botanic Gardens (Darrel Herbst and Ken Nagata, personal communications). Paul Weissich reports the seedlings were destroyed as undesirable without further distribution. There is no record of any further official distribution by Lyon Arboretum, though such might have been done informally. Ken Nagata recalls subsequently, Coccinia grandis was given to Lyon Arboretum as a "medicinal plant." There is no record of the transaction, and so it is unknown whether this was a second introduction, or progeny from Don Anderson's introduction.

It was originally described by Linné in 1767 as Bryonia grandis (Mant. Pl. 1: 126) with no type locality or type specimen indicated. In 1967, Jeffrey designated LINN 1153/2 as lectotype (Fl. Trop. E. Afr. 68). Bryonia is now limited to four species from Asia, N. Africa, Europe, and the Canary Islands. In 1834, Wight and Arnott (Prodr. Fl. Penin. Ind. Orient 1: 347) published the genus Coccinia for the tropical species of Bryonia, with C. indica W. & A. as type species. Apparently, C. indica W. & A. is a later synonym of C. cordifolia (Linn) Cogn., and so the type species is C. cordifolia. Later names applied to this genus are Cephalandra Schrader (1836) and Cephalopentandra Chiorenda (1929). Taxonomy in the genus is not settled, and estimates of the number of species run from 14-50. The native range of the genus is circum-Indian Ocean. The natural range of C. grandis alone equals the natural range of the whole genus. A quick scan of floras available in my own and

the UH libraries has produced the following range extensions: Philippines, apparently as an escape from cultivation; South Texas (as C. cordifolia, naturalized along the coast); Cuba, Jamaica, St. Croix, and Barbados. No records were found for Mexico, Guatemala, Costa Rica, or Surinam. In all places, C. grandis seems to be restricted to hot, dryish, coastal lowlands.

The vine is a rank grower, quickly smothering ground, shrubs, and trees in a solid blanket. In Hawai'i it can remain green year round, but in dry and temperate areas it dies back. It does not have tuberous roots, but both roots and stems are very succulent, and may be quite sufficient for storing water during dry weather. Older stems reach 5 cm in diameter with occasional adventitious roots where the stems run along the ground. Leaf blades may be shaped like those of cucumber (between heart-shaped and pentagon-shaped) and 4 cm long, or 3-5 lobed and up to 10 cm long. Flowers are white, about 2-3 cm long, held upright, shaped like those of Campanula. Males and females are on separate plants. Fruits are shaped like little gherkins, 4-5 cm long, turning scarlet at maturity, and are popular with red vented bulbuls. It should be expected that the bulbul will spread this plant beyond its present locations on O'ahu. The population on the UH campus covers only about 100 square meters. Only female flowers could be located in August, 1985. Fruits have been observed, but there is little evidence of spread due to seeds, and the population may be just a single plant, or very few plants. Cliff Smith reports the Keolu Hills population of male and female plants covers perhaps 40 hectares. Additional populations have been found along the entrance to Lyon Arboretum, the intersection of Ala'ula Way and Pamo'a Road (behind the University), along most of Makiki Heights Drive and lower Tantalus Drive, on Nehoa Street near Nehoa Place, and on Auwailimu Street (behind Punchbowl) from the cemetery to Roosevelt High School. Cliff Smith believes the range on the Windward side to be between Keolu Hills and Kaiwainui Swamp..

In September of this year, a single plant was found on the Big Island at Kamoa Point just south of Kailua-Kona by Carolyn Corn. In November I found the plants very common along Hualalai Road and Alii Drive south of Kailua. It is presumed the plants have been there for a few years, as some plants were quite large. Fruits were numerous.

The young fruits and shoot tips are eaten in Asia, but there is no evidence it was imported to Hawai'i for food. It is not present in any local community gardens, nor is it clear that its presence in Texas or the Caribbean is attributable to its use as food. Art Whistler has found no report of it anywhere in Polynesia, and no one outside Asia reports its use as food. Both flowers and fruits are attractive and might entice someone to import it as an ornamental. Hortus Third lists it as an ornamental in North America.

No flora lists Coccinia grandis as a noxious weed, though most report its rank growth. In Hawai'i it is clearly weedy, and should be considered as potentially noxious. While I have seen some slight grasshopper damage, the plants are not seriously attacked by insects or disease. This combined with its rank growth and potential for spread should be cause for concern. Those who find themselves in the coastal lowlands should watch for this plant so its progress can be monitored. New locations should be reported to the Bishop Museum and/or UH Manoa Botany Departments.

George Linney,
Botany Department
University of Hawaii at Manoa

MEMBERSHIP

Membership in the Hawaiian Botanical Society is open to anyone interested in all Hawaiian plants, native or introduced.

The membership dues, payable at the beginning of each year, for each calendar year are as follows:

Student	\$4.00
Regular	\$7.50
Family	\$10.00
Life (for individuals only)	\$100.00

Send cheque or money order to Ms. Karen Asherman, Department of Botany, University of Hawaii at Manoa, 3170 Maile Way, Honolulu, HI 96822.

President Lewis called the meeting to order at 7:30 p.m. The minutes of the May meeting were read and approved.

Derral Herbst gave the Treasurer's report as follows:

Balance as of May 1	\$2407.68
Receipts	287.50
Gifts	3.50
Science Fair	7.28
Expenditures	520.41
Interest	9.88
Balance as of June 1	\$2187.13

Libby Powell of the Conservation Committee reported that Science recently published an article on wood chipping of Hawaiian 'ohi'a forest for electricity generation on the Big Island. Society members were asked to write to their legislators to stop this degradation and eradication of low elevation rainforest.

The State Department of Land and Natural Resources (DLNR) is sponsoring a program called "Million Trees of Aloha". One million seedlings will be given away for reforestation projects. Society members were asked to write to the DLNR to find out what trees will be given away, and where the seedlings will be planted. Libby suggested that we offer to participate in planting of native trees.

For the Newsletter Committee, Dr. Abbott announced that the second Newsletter for 1985 had gone out; the membership list will be out in August.

Under old business, the May 25 field trip to Lyon Arboretum and Manoa Falls area, and potluck lunch afterwards, was enjoyed by Society members as well as members of the Hawaiian Entomological Society.

Don Talbot of Hawaiian Paradise Nursery spoke on bromeliads, and brought many prickly and fleshy examples to show us. There are approximately 600-800 varieties of bromeliads in Hawaii, perhaps as many as 1,000 due to the efforts of Lyon Arboretum and the Hawaiian Bromeliad Society. Bromeliads have become naturalized from man-made plantings in areas such as Tantalus, Aiea Heights, and Punalu'u.

HAWAII'S BOTANIC GARDENS:
PANACEA OR PANDORA'S BOX IN THE
CONSERVATION OF HAWAII'S NATIVE FLORA

Wayne C. Gagne
Education Department
Bishop Museum
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Honolulu, HI 96819-0916

I read with considerable alarm Paul Weissich's article entitled "Honolulu's Botanical Gardens: History, Physical Set Up and Goals" (Hawaiian Bot. Soc. Newsletter 24:27-36). It appears to me that in the struggle to save Hawai'i's native flora from extinction and conserve them in their natural ecosystems, most local botanic gardens are increasingly becoming part of the problem rather than the solution. Mr. Weissich espouses the idea that Hawai'i help save the flora of the tropics by importing thousands upon thousands of species and planting them in established and new botanic gardens or "alternate sites" all over the Hawaiian Islands. But not a word was written on the problems associated with the increasing number of these species that are naturalizing, competing with and displacing the native flora! Mr. Weissich, we can't have it both ways. Either we concentrate on saving our own flora and native ecosystems, while urging others to do the same in their respective countries, or we face the impossible situation of more and more of Hawai'i's flora disappearing due in increasing measure to the invasion of the same foreign plants Mr. Weissich and others of his ilk are importing and planting. Not only are these naturalizing aliens a detriment to the native flora, they also infest natural areas, national parks, pastures, agricultural areas and private property and thus become a private and public nuisance and expense to try to remove, first mechanically, or with herbicides, and occasionally, biologically when all else fails. Those weedy ornamentals, for example, Kahili ginger (Hedychium gardnerianum), that become "economically important", get us into a real biological bind too, since economic interests usually prevail where there is a conflict with saving native flora and "doing business as usual." Either such ornamentals are not universally regarded as weeds, or in the rare instances where there is unanimity, biological efforts are stymied because of the difficulty of finding host-specific herbivores and pathogens. Along with the weedy Kahili ginger, a virtual maelstrom of other gingers (Zingiberaceae) have been introduced here, about a half dozen species of which are aggressively naturalizing.

As a systematic entomologist, I too am greatly distressed about the destruction of the world's tropical entomofauna. But were I to advocate the introduction of many of the, say, spectacular tropical butterflies, in order to save them, I could justly be branded daft. Yet, thousands of plant species are being brought in by the very pillars of society, an activity which I maintain is helping to destroy, not save, Hawai'i's native flora. John Obata's report on the spreading in the Ko'olaus of the ornamental melastrome Oxyspora paniculata in the same issue of the Newsletter mentioned above is merely the top of the botanical iceberg. Take a walk along the Ahuialama Trail above Lyon Arboretum if you don't believe me. Practically every year I hike that area, I see new naturalizing alien ornamentals working their way inexorably, or sometimes by leaps and bounds, into the depths of the Ko'olaus. Enough is enough! St. John's manual on Hawaii plants lists 4643 exotic (or alien) species. I am informed, by the authors of the new Hawai'i flora now in preparation by the Bishop Museum, that 700 species of alien plants, about a third of which were purposeful introductions, are sufficiently established or naturalized to be considered for inclusion in the new flora. Do those who introduce and liberate these plants take responsibility when these plants become weedy? Not on your life! No self discipline nor hardly a word of caution to be found!

Without any strong leadership on the part of those fostering such activity, the lay public and certain part management, commercial entrepreneurs feel free to add to the botanical chaos. For example, the manager of Ho'omaluhia Park has "written off" Hawaiian flora below 2000 feet as "wiped out, crowded out, or it doesn't care" (Sunday Star-Bull & Adv. 7 July 1985). It is disturbing enough to observe the botanical cornucopia springing forth from private property, and ever more so to see some of our finest parks being degraded or ruined in this manner. For example, Koke'e State Park which harbors the State's best native mesic forest is being overgrown by a menagerie of naturalizing ornamentals planted by leasees and park personnel. Among them, Lasiandra (Tibouchina semidecandra) appears to have been planted along much of the park's main road and is rapidly invading the adjacent native forest. To what end? "Beautification" to please the tourist?

I am cognizant of the enormous popularity of "exotic" plants. Whether it be at festivals, flea markets, rummage sales, plant exchanges, or garden clubs: they appeal to specialists, fadists, florists and "green-thumbs" alike. But to couch such endeavors as somehow desirous and compatible with conserving Hawai'i's

native flora simply does not wash with biological reality. In addition to the direct degradation of native ecosystems by alien flora, and the invasion and the tenacity of disturbance-adapted flora, there is the even more unsettling indication of concomittant introduction of alien pests and pathogens with these plants. The best intentions and efforts of quarantine personnel surely cannot cope with this botanical avalanche. It seems more than a coincidence, for example, that three species of legume-feeding jumping lice in the genus Heteropsylla have suddenly established within the past few years. Does this have something to do with the emerging interest in nitrifying trees and biomass plantations? The annual Proceedings of the Hawaiian Entomotogical Society now record upwards of 20 species newly establishing insects and related arthropods in the Hawaiian Archipelago each year. Hardly a year passes when one or more of these become a major pest to both alien and native flora like - spiraling white fly, orchid weevil, banana root borers, yellow jackets -- I could go on an on. Surely many of these are undetected, or practically undetectable, associates on introduced plants. Some of these insects are especially frightening when they attack common and rare species of native plants alike. For example, the black coffee twig borer (Xylosandrus compactus) attacks a wide range of native and introduced plants. This minute beetle could well account for the apparent impending extinction of one of our most magnificent native trees, the mehomehame (Drypetes phyllanthoides).

While I realize that my anguished words are not likely to result in any sudden about-face in attitudes, I urge that promulgators of plant introductions such as Mr. Weissich see the need for greater self-policing. Surely some plant groups such as the melastomes and gingers have become sufficiently notorious naturalizers that unanimity would be reached on banning further introductions and comming to grips with the eventual control of the escapees. How much more of Hawai'i's native ecosystems must be laid to waste by a "jungle" of Koster's Curse, Kahili ginger, Oxyspora paniculata, or you-name-it? How long will the beleagured few maintain their enthusiasm to try to help the National Parks or The Nature Conservance maintain some semblance of the native biota within their confines by having to continually battle the alien flora foe? Will the native flora even get first priority, or will the naked Emperor still continue to proclaim concern for the conservation of the native flora? The last thing the native flora needs are botanic gardens full of alien species in their midst at all elevations! All too few are the exceptions such as the Maui Botanic Garden, which focuses on the native flora rather than striving to cover all botanical bases. Botanical charity begins at home.

The "Noah's Ark" approach is untenable as a conservation ethic for Hawaiian botanic gardens.

Acknowledgements

This article was conceptualized with response to the thought-provoking article by my former entomological colleague Dr. Francis Howarth entitled "Biological control: panacea or Pandora's box?" (Proceedings Hawaiian Entomological Society 24:239-44, 1983.)

Minutes of the October, 1985 meeting

President Lewis called the meeting to order at 7:30 p.m. The minutes of the June meeting were read and approved.

President Lewis again reminded Society members that the Newsletter Committee welcomes contributions such as articles or appropriate announcements for future issues of the Newsletter.

The Native Plants Committee announced that 4 species have recently been proposed for Federal listing as endangered species: Abutilon menziesii, Hibiscadelphus distans, Mezoneuron kawaiense, and Scaevola coriacea. Gardenia brighamii was recently listed as endangered.

Members were reminded to bring in plants or plant products for the next plant exchange which will be in December.

Under old business the President outlined a proposal to protect Marsilea villosa in Koko Head by restricting access to the habitat by four-wheel drive vehicles. This could be done by strategically locating a barrier so that vehicles could not go through it nor around it.

Under new business President Lewis announced that Dr. Abbott would be Nominating Committee chairperson, and Bill Bush would be the Society auditor.

Vice-president Bornhorst introduced Mr. Steven Nims from Trees of Hawaii who gave a talk entitled "Tree Pruning Standards".

Respectfully submitted,
Christa Russell.

SELECTED RESEARCH AND
EDUCATIONAL INSTITUTIONS OF SOUTH CHINA
22 DECEMBER 1984 - 23 JANUARY 1985

B. Z. Siegel
Pacific Biomedical Research Center
University of Hawaii at Manoa

S. M. Siegel
Department of Botany, A&S
University of Hawaii at Manoa
Honolulu, Hawaii

II. Scientific and Ethnobotanical Observations of South China

Gin Hong is located on the banks of the Mekong (Lanchang) river at 1200 meters. To reach here a five hour drive on narrow, partially graded, winding mountain roads was required to travel about 130 km from the Institute of Tropical Botany. Not only road surface, but also trucks, small tractors, pigs, donkeys, carts, children, peasants and road work gangs all ensured our pace.

After lunch and a rest at a scenic hotel (Western plumbing), we were honored by a visit from Governor Zhao, a Dai, and Vice Governor Xu, a Han Chinese, and the chief administrative officers of the prefecture which has an area of 19,000 sq. km and an 840,000 population, two thirds of which are Dai people.

1. The Dai Morning Market in Gin Hong

The free market on New Years Day was a special one, as the Dai people were celebrating a Western holiday.

The market was set up curbside on both sides of a moderately wide street, and extended for about 500 m. For the most part, goods were placed on sheets, mats or low tables directly at the curb. Among the items for sale were tobacco; special wrapper from Cephalanthus leaves; fibre from Musa textilis; and beeswax. Most of the wares were foodstuffs either processed (e.g. rice, flour, chili powder) or raw (various greens and fruits). Meats, especially pork, fish and poultry seemed abundant.

In all 20 families of seed plants were identified among the foodstuffs offered. They were:

Amaranthaceae - various Amaranthus spp. similar to ung choy

Amaryllidaceae - Allium spp. including onion, chive, garlic and leek

Anacardiaceae - Spondias sp. fruit

Araceae - Colocasia esculentum (taro) leaf and stem, but unlike Polynesia the tuber was not eaten.

Camelliaceae - Thea sinensis var. assamica (tea)

Capparidaceae - Crataeva nervata as shredded pickled roots

Chenopodiaceae - Spinacia oleracea (spinach)

Compositae - Lactuca scariola var. sativa (a lettuce) only stem is eaten

Cruciferae - 5 Brassica's, including B. oleracea var. capitata (head cabbage), var. botrytis; B. chinensis; B. caulorapa (cauliflower); B. integrifolia (bitter cabbage) and Raphanus sativus (red radish)

Cucurbitaceae - Cucurbita moschata, a pumpkin, both fruit and blossoms, Citrullus vulgaris, watermelon; Sechium edulis

Dioscoreaceae - Dioscorea tubers

Euphorbiaceae - Phyllanthus sp., a source of fruit

Gramineae - Oryza sativa (rice), both white and black cultivars; Dendrocalamus sp., bamboo shoot; Saccharum (sugar) for both chewing and some processing

Labiatae - Mentha haplocalyx, a water mint

Musaceae - Musa sapientum (banana)

Papilionaceae - Arachis hypogla, boiled in the shell, Pisum sativum (peas), pods and green shoots; Sesbania grandiflora pods; Dolichos lablab (beans)

Pinaceae - Pinus yunnansis seeds (pine seeds)

Piperaceae - Piper betel, Piper nigrum (peppers for spice)

Rutaceae - Skimmia arborescens fruit; Xanthoxylum utilis (a spice like pepper)

Solanaceae - Capsicum annuum varieties; Solanum esculentum fruit; Solanum melongena fruit; Solanum coagulans young shoots; Solanum spirale root (tomatoes, green and red peppers and potatoes)

Umbelliferae - Coriandrum sativum, seeds and shoots; Eryngium foetidum, spice leaf

Zingiberaceae - Alpinia spp. various gingers.

Young shoots of edible fern, Pteridium aquilinum were also on sale, as were round mats of dried river algae and dried fruiting bodies of Auricularia.

2. Yunnan Medicinal Plant Institute

The Institute covers an area of about 24 hectares and regularly grows over 20 species of plants with therapeutic value.

One of the most important medicinal plants mentioned was Chinese Cardamon, Cardamine sp. (Cruciferae), famous as a treatment for digestive ailments. Although found at lower elevations, it grows best above 1000 m. Xishuangbanna cultivates 3000 hectares out of China's 20,000 ha.

The resin Styrax tonkinensis (Sturacaceae) is chewed like gum benzoin or tincture of benzoin, for headaches, digestive ills and skin irritations. Santalum album (an Indian introduction) finds use as an intestinal parasiticide and also for bronchial decongestion. Strychnos nux-vomica (Loganiaceae) and also S. cathayensis and S. nitida are used in treatment of vascular diseases. Quisqualia molica (Combretaceae) root is used in treatment of diarrhea but the fruit can act as an emetic. Rauwolfia verticillata (Apocynaceae) root preparations are used for treatment of hypertension, akin to use of R. serpentina root preparations for anxiety. From the Menispermaceae, the vine of Cissampelos paraira var hirsuta finds use as a source of a curare-like principle. Brucia javanica (Simarubaceae) root contains an amoebacide, and extracts of Elaeocarpus (Elaeocarpaceae) and Cephalotaxus hainanensis (Cephalotaxaceae) fruits and shoots find use in cancer therapy. Terminalia (Combretaceae) leaves find use both for intestinal ailments and upper respiratory tract inflammation. Antimalarial preparations are made from the fruit and leaves of Artabotrys hexapetalis (Anonaceae). Plumbago shoots contain an antirheumatic principle. Roots of Urtica sp. yield a toothache remedy. Litsea cubeba (Lauraceae) a source of cube

resins is used in treatment of stomach ailments and headaches. Euphorbia sp. latex is useful for ringworm lesions. A number of Orchidaceous genera are also shown to be medicinal, including: Dendrobium (for Asthma) and Pholidota (for a general tonic).

Our hosts were Director Zhou and his assistant Mr. Go, who is one of the Mountain people knowledgeable in herbal medicines.

3. Yunnan Institute of Tropical Crops: (including the Rubber Research Institute)

The major object of study and cultivation here is Hevea brasiliensis (Euphorbiaceae), although attention is also given to coffee, oil palms, cacao, cardamon, other medicinals and tropical fruits. The latter include mango, avocado, Passiflora (passion fruit), sapote, Macadamia, pineapple, and cashew. Edible Passiflora species here reach the size of pomelo or even honeydew melons and weigh kilograms each.

Significant importance is given to Derris elliptica and Acanthopanax (a ginseng). The Coffea section is planted with trees of C. arabica, C. robusta and C. excelsa. New applications are also being developed for the oil palm -- the oil from which is used for anti-corrosion, steel quenching, coolant, and lubricant. The oil and oil cake are edible, rich in glyceryl palmitate.

China, with growth and development of transportation and other industries, imports rubber; about 60% goes for tire manufacture, where Hevea rubber's superiority is recognized. In tropical China 500,000 hectares are rubber plantation, as already noted. In Xishuangbanna, 50,000 hectares produce 60,000 tons of rubber annually. Damaging cold air currents draining off of the Tibetan Plateau prevents rubber from being grown in the mountains at elevations greater than 900 meters. Another limit is ecological and conservationist in nature since tropical forests must be protected as much as possible as they are highly complex communities, which, if extensively disturbed, will cause erosion, flooding, and damage to the lowland agricultural settlements.

In Malaysia, Hevea brasiliensis is ready for the latex tap at five years but in Xishuangbanna 6-7 years are normally required and the 1200 kg/ha/yr is somewhat below Malaysian performance. The productive life of a tree is 25 years. In this area rubber production involves both state-owned lands and free market activities of the Dai and mountain peoples.

Substitutes for Hevea among latex-rich plant groups, e.g. Asclepidaceae, Compositae, Euphorbiaceae, Apocynaceae, Moraceae, are not treated seriously here. Parthenium (Mexican guayale) has been introduced, and has inflorescences reeking of isoprenol, but is not being considered as a source of latex. More successful is Ecdysanthera utilis (Apocynaceae, wild rubber), but it remains a curiosity. Of more promise are new Hevea hybrids based on strain selection. The principal feature is early tap readiness -- 3 years instead of 6-7.

Rubber research is basically conservative and wholly practical in orientation. Pei's efforts to develop agroecological concepts and practices in Hevea plantation practice are met by the rubber people with detached interest. We are of the opinion that the pressure to expand China's domestic rubber production could lead to great increases of Hevea plantations in Xishuangbanna. Currently 2.6% (approximately) of the total land surface of the prefecture is in rubber plantations. Any expansion, no matter how seemingly necessary, will take its toll by removal of a stabilizing factor--the multi-level, multi-species natural community. If this were to be replaced by traditional bare ground Hevea plantations to the extent, say, of 10% or more of Xishuangbanna's land area ($\geq 200,000$ hectares), significant changes in microclimate, water relations and ecological balance could destabilize the entire lowland area involved, altering ecosystems, trophic networks, and also the quality of life of the ethnic minority peoples of the forests. Such effects could be irreversible. We suggest that Pei's experiments with multispecies, multi-story communities may hold the key to a "compromise" solution, although even the most successful application of this complex community concept can only partially mitigate effects of loss of native forest.

3. The Tea Factory and Gardens:

The tea factory and gardens are located in the town of Shangshan, Menghai County 50 km west of Gin Hong at 1200 meters elevation. Here is a Thea shrub approximately 800 years old and commemorates the place where tea as a beverage is said to have originated. It was explained that the varietal epithet "assamica" was a botanical error, because, having been found in Assam, India, it was assumed to be native to that part of India without any effort to track it from there to China.

Mr. Lu Yun, factory manager, explained that the large facility is made up of four "workshops" for Black, Green,

Pu-Erh and Brick teas. Pu-Erh is a specially fermented tea of Yunnan Province. Tea here is harvested from March 10th to October 20th with a total yield of 1700 tons. There are 28 collecting stations run on a free market basis. The collecting area is about 10,000 hectares. The harvest has three peaks--March (Spring tea), June-July (Rainflower tea) and September (Riceflower tea). The best quality green tea is from the Spring harvest, and best black teas are picked first after the rainy season. The Tea Factory employs 600 regular workers and 300 on contract. The quality of the tea leaves is judged by eight criteria:

1. Leaf shape and pubescent bud content
2. Leaf tenderness
3. Contaminants (e.g. weed leaves)
4. Intact leaves (i.e. absence of leaf fragments)
5. Fragrance
6. Taste
7. Color of tea water
8. Chemical composition
 - a. Thein (Phenolics)
 - b. Amino acids
 - c. Ash
 - d. Cellulose

Under natural conditions, tea is often grown with some degree of shade, much less for black tea, much more than green tea. Any and all of the following co-dominants in these higher elevation forests (≥ 1200 m) serve as shade trees--Cinnamomum glandulifera, Lindera sp., Phoebe sp. (all Lauraceae), Castanea, Castanopsis and Quercus (all Fagaceae), Acer, Elaeocarpus.

We note in passing that the camphor tree growing here is C. glandulifera not C. camphora. The yield of camphora in the area is about 200 tons/year, but exact acreage was not available.

The principle basic research project now beginning at the Tea Institute concerns photosynthesis and its environmental determinants.

4. Kunming Institute of Botany:

Professor Wu from Kunming Institute of Botany gave a dinner party at the hotel in our honor. It was a great feast with many toasts to goodwill, cooperation with UHM and a pleasant, productive visit. The meal included a beautifully prepared fish, many meat and vegetable dishes including deer tendon. Dessert was Gleditschia jelly.

Founded in 1938 the Institute covers 45 hectares and has a staff of 960, 50% technical including 18 senior (professional) scholars. Its units are: Taxonomy/Phytogeography, Phytochemistry, Physiology and The Garden. The technical staff in Taxonomy/Geography is 40. Professor Wang showed us the herbarium of 600,000 sheets, but pointed out that 4000 living specimens were located in the institute garden. There are 1000 type specimens. A geobotanical map showed North Yunnan Abies forests and mountains up to 6000 m, central evergreen broad leaf forests and the southern tropics. Of 15,000 species of seed plants in Yunnan, the institute has 4000 in collection. Exhibited were plants currently used as sources of starch in Yunnan--Lithocarpus, Quercus (Q. variabilis also is a source of tannin); sources of fibre--Calotropus, Musa (e.g. M. textilis), Reevesia; for oil--Camellia (cooking), Hodgsonia and Hevea (industrial). In passing we were informed that the Institute's library has over 80,000 volumes.

Correaria spp. are being developed as a source of gums. The exhibit also included the olive; a new cultivar of Olea europaea from Albania has been established that begins to bear fruit by the 4th-5th year.

Among medicinal plants, Paris yunnanensis (Trilliaceae) rhizome extracts are vasoactive, reduce pain and swelling and stop bleeding; Dendrobium (Orchidaceae) stems contain substances reducing trachyitis; and antifertility steroid saponins from Aloe, Dioscorea and Agave are under study for commercial development.

Hemsleya spp. tubers contain a promising antibiotic principle which appears to be steroidal - cucurbitacin. New sources of colchicine are being developed from Gloriosa lily and Iphigenia (also Liliaceae).

A dramatic discovery is a compound very effective in the treatment of epilepsy that has been found in the root of Cynanchum otophyllum (Asclepidaceae). Of unusual interest was the development of new wheat and rice cultivars by selection from anther cultures. The discovery of beta-ecdysone (insect molting hormone) activity in extracts of Cyanotis arachnoides (Commelinaceae) may greatly increase the yield of silk by stimulating the cocoon extruding pupal stage of the silkworm.

Of course, Panax spp. and other Araliaceae continue

to be of interest to meet the ginseng market, which is still growing.

Other medicinal plants included:

Adiantum (Adiantaceae), an antibiotic
Mahonia (Berberidaceae), an antibiotic
Euphorbia (Euphorbiaceae), an anti-inflammatory
Alstonia (Apocynaceae) anti-fever
Heracleum (Umbelliferae), an anti-irritant
Angelica (Umbelliferae), an anti-irritant
Asarum (Zingiberaceae), for gastritis
Salvia (Labiatae), for cardiac pains
Ephedra (Ephedraceae), an anti-tussive
Swertia (Gentianaceae), for toothache
Trevesia (Araliaceae), for gastritis

Many of these genera are familiar in western Materia Medica but the work in China relates to their introduction, cultivation, chemical standardization, effectiveness, productivity and market distribution.

A special section is devoted to edible and medicinal fungi grown artificially. For example, the bamboo fungus, Hypotrella, is useful in the treatment of skin irritations and in treatment of severe burn cases, and Ganoderma lucidum extracts have anti-tumor properties. High yielding edible fungi cultured under artificial conditions include Dictyophora, Hericeum and Pleurotus. Engleomyces produces cytochalasin, a chemical of use in cytological and ultrastructural research.

The Phytochemistry Laboratories at the Institute operates an excellent set of analytical facilities.

Mr. Sun, who is in charge of Phytochemistry, works in the areas of essential oils, terpenes and phenolics. Most of his work is with vascular plants, but he has increasingly given more attention to lower forms, especially lichens. For example, Evernia divaricata contains 2.8% essential oil by weight; from this oil a valuable substance, ethyldivaricatic acid has been isolated. The lichen Cetrariastrum has yielded a new depsidone. Mr. Sun's laboratory projects also include isolation and determination of: kaurenoid diterpenes from Rabdosia (Labiatae); many furanocoumarins from Heracleum (Umbelliferae); coumarins from Peucedanum (Umbelliferae); and essential oil terpenes from Citrus medica. They have also determined ¹³C-NMR spectra of various umbelliferous terpenes.

Messrs. Zhou and Yang discussed their work, part of which is done jointly with colleagues in Professor

Tanaka's laboratory, Hiroshima University School of Medicine. They are studying gastrodin, a potential sedative-hypnotic from Gastrodia spp. (Orchidaceae). The compound is a glycoside of p-hydroxy-benzylalcohol. In Hemsleya (Cucurbitaceae) they found antibacterial oleanolic acid saponins active against bronchitis, dysentery and tuberculosis.

In the root of Dolichos (Papilionaceae) they reported a triterpenoid, the methyl ester of medicaginic acid glycopyranoside. And in a continuing search for sources of ginseng, they have isolated, from Panax notoginseng (Araliaceae) a series of dammarine saponins, the notogensenosides. Finally, Professor Mu discussed the laboratory and clinical trials of Cynanchum otophyllum extracts, which are 80% effective in the treatment of epilepsy with an ED₅₀ of 10.2 mg/kg. The active agents appear to be two new steroidal glycosides, Qingyang-shenosides A and B. Mr. Rui identified his insect hormone from Cyanotis as - Ecdysone and found the highest content, 2.8% of dry weight, in the root.

The Plant Physiology laboratory, headed by Professor Duan is mainly concerned with applications of tissue and cell culture techniques and the principles of genetic engineering to medicinal plants. An independent area of interest is the phytophysiology of basidiomycetes.

Mr. Zhang's tissue culture program includes work with Anisodus (Scopolia), Rauwolfia yunnannensis and Panax notoginseng. The details of progress were confined to Anisodus. Cultures of A. acutangula produce scopolamine and hyoscyamine alkaloids. (The former achieved notoriety some years ago as a "truth serum" and has been used therapeutically.) This work has been conducted both with callus explants and in suspension. Regulators of alkaloid synthesis (stimulants) include phenylalanin, naphthaleneacetic acid and light. Lactalbumin hydrolysates are also active, and kinetin specifically increases scopolamine.

Mr. Ding in Professor Wang's laboratory informed us that the latter just returned from two years as a visiting scientist of the Max Planck Institute in Berlin-Dahlem. Planned is an ambitious program of developing the crown gall organism, Agrobacterium tumefaciens, as a plasmid transfer agent. The object is the introduction of specific alkaloid biosynthetic capabilities into ideal host cell lines. They appear ready and able to undertake a state-of-the-art genetic project.

A final project on mushroom culture reviewed the successful use of sawdust (from trees in the Fagaceae)

supplemented with wheat seed aleurone (pericarp) and no other nutrient source. Genera so cultured include Lentinus, Pholiota, Hericerum and Flammulina. With Lentinus, 1 kg dry weight of sawdust yields 0.8 kg of fresh mushrooms in three months. The same sawdust can be reinoculated 5-6 times without loss of yield.

A tour of the Institute's Old Botanic Garden ended the day. The "forest" of tree camellias, 27 cultivars (of the Institutes total of 120) was striking. Most of them do not fruit, but a few do produce viable seed and are being studied genetically. It was suggested that non-fertile forms may have chromosomal problems such as non-disjunction. The only cytological information is that extra large double flowers are not necessarily polyploids. Among the extensive Gymnosperm plantings, Cryptomeria, Cunninghamia and Taiwania were represented.

5. The Yunnan Forestry College:

It was founded in 1979 to foster research in the fields of forest industry, forest protection, forest management, logging, wild animal management and timber processing. Since 1984 the Master's as well as Bachelor's degrees have been awarded and at present there are 800 baccalaureate students and 18 post graduates. By the end of 1985 an enrollment of 1000 is planned, and by 1990, 2000 undergraduates plus 50 post-graduates. The staff now totals 650 with 200 teaching positions. Of these there are the equivalent of 4 full professor, 8 associate professors, 79 assistant professors and 109 instructors in rank. Unlike many academic or research institutes in China, teaching and research are intermixed here. New emphasis is being placed on environmental protection and integrated pest management.

The College herbarium contains 100,000 sheets (10 registered type specimens in the Fagaceae) and is complemented by an unusual collection of forest pathogens. There are over 10,000 specimens representing over 300 pathogens for 390 host species in 72 families. Heart Rot of Pine (Trametes) and Blister Rust of Pine are of special concern to the area.

Professor Hsu of the college with Prof. Jen from Beijing has recently completed a definitive account of and key to the 165 Yunnan species of Fagaceae in the 7 genera Fagus, Castanea, Castanopsis, Lithocarpus, Trigonobalanus, Cyclobalanopsis, Quercus. Central Yunnan has the fewest species, the south and SE portions the greatest number of the Fagaceae, generally. The

evergreen sclerophyllous oaks are richest in the NW which combines both alpine and subtropical zones.

The ecologically distinctive nature of Yunnan is shown when the ratio of the "number of species/number of genera" is compared with that for nearby provinces and bordering countries:

Region	<u>Number of Species</u> <u>Number of Genera (ratio)</u>
Yunnan	23.6 (165/7)
Guizhou	7.4
Sichuan	7.6
Guangxi	9.1
Guangdong	6.3
Hunau	4.7
Hubei	4.0
Vietnam	3.1
Laos	3.3
Thailand	1.6
Burma	2.0
India	2.9

January 11th ended with a visit to the Tsao Shih Temple near Kunming. Of interest were Cryptomeria, Camellia and Podocarpus over 100 years old, and a flowering plum from the Yuan Dynasty over 600 years old.

6. Yunnan University:

The University is 62 years old with a library collection of one million volumes, 2000 periodical titles; the herbarium consists of 40,000 sheets.

Of the 4000 students, 2500 are science majors in Biology, Physics, Chemistry and Mathematics. These departments' faculties number 90, 120, 100 and 70 respectively. In addition the Institute of Microbiology has a staff of 50 and the Institute of Ecology and Geobotany numbers 25.

A Biology degree requires 125 classroom (or laboratory) hours each in chemistry, physics and mathematics; a student must take nine subjects each term. We were surprised to learn that, as in our Arts and Sciences, humanities students must have science electives and science majors must take one non-science course each and every term. The Institutes are exclusively for research, although here as elsewhere in China there is serious intention to intermingle teaching into their programs. The visit finished with some

discussion of Professor Jiang's own research in the Institute of Ecology and Geobotany. He has authored a definitive geobotanical study "Distributional Features and Zonal Regularity of Vegetation in Yunnan". This was published in Acta Botanica Yunnanica 2:20-32 (1980), but he generously provided a copy in English. Although too complex for summary here, he has identified general similarities in main vegetation types in Yunnan. The vegetation is transitional, linking East Asia and South Asia, and resulting from the monsoon climate and the geophysical contours of the Yunnan Plateau. "The composition of life forms in both regions are identical, but the dominants...are geographic replacements of the same genera..."

7. The Ding-Hu-Shan Arboretum:

It is located near Zhouquing city some 90 km from Guangzhou. Within its boundaries is a UNESCO "Man and the Biosphere" (MAB) registered monsoon rainforest preserve established in 1979, and is a matter of great pride to the Institute. The 100% native forest is a 300 hectare tract wholly enclosed by the Arboretum's total of 1500 ha.

The mean annual rainfall is 1800 mm. The native biota consist of 1700 plant species, 150 birds and 40 mammals. The "Man and the Biosphere" tract ranges up to 1000 m elevation.

The facility is run by a staff of 30 including eight professionals. A weather station with sensors positioned at the 400 m level is perched on a tower rising free of the canopy. The two main areas of research are conservation/resource management and physiological ecology, especially the relation between water stress and photosynthesis.

In this protected monsoon forest, Euphorbiaceae, Fagaceae, Lauraceae, Moraceae, Myrtaceae and Rubiaceae are important families. Important genera include: Acalypha, Antidesma, Codiaeum, Phyllanthus (Euphorbiaceae); Balanopsis, Castanea, Castanopsis, Lithocarpus (Fagaceae); Actinodaphne, Cinnanomum, Lindera, Litsea (Lauraceae); Artocarpus, Broussonettia, Cecropia, Ficus (Moraceae); Melaleuca, Eugenia, Syzygium (Myrtaceae); Cephalanthus, Hedyotis, Psychotria, Morinda (Rubiaceae). Important forest monocots are in the palms and bamboos. Palmae--Archontophoenix, Calamus, Caryota, Livistonia, Roystonea. Bambusoideae--Bambusa, Dendrocalamus. The Pandanaceae, Cyperaceae and other Gramineae are also represented. The Psilopsid, Lycopsid

and Sphenopsid flora includes Psilotum, Lycopodium, Selaginella, Equisetum (P. nudum, L. cernuum also in Hawaii, and S. tamariscina, E. debile, which are not). Important Pteropsid species are Osmunda vachellii, Dicranopteris linearis, Mecodium sp., Lindsaea sp., Davallia sinensis, Nephrolepis hirsutula, Pteridium revolutum (and others), Adiantum caudatum, Asplenium austro-chinensis, Cyathea sp., Dryopteris varia, Grammitis sp., Vittaria sp.

Bryophyta and lichens were also abundant even in this dry season, but time and expert counsel for their inclusion were lacking. Hepaticaceae both leafy and thalloid are present, but ready access to the wet places was not possible. Riccardia, Pallavicinia, Bazzania, Cephalozia, Plagiochila, Frullania, Lejeunea and Marchantia are all well known in the forest, as is Sphagnum. Common mosses fall into Dicranaceae, Leucobryaceae (8 Leucobryum spp.), Fissidentaceae (5 Fissidens spp.), Funariaceae (Funaria hygrometrica), Bryaceae (Bryum coronatum), Mniaceae, Neckeraceae (Homaliodendron spp.), Thuidiaceae (Anomodon, Thuidium, 4 other genera), Hypnaceae (Hypnum and 4 other genera), Polytrichaceae (Pogonatum aloides, P. spuriocirratum, Polytrichum formosum). There are 15 other families many of minor incidence.

8. South China Institute of Botany:

The Institute was founded in Guanzhou in 1928 by Professor Chun from Dr. Sun Yat Sen University as a taxonomy program with 26 staff members. In 1954 it was transferred to the Academica Sinica.

The current staff total 570 with 270 of these professionals in six departments--Taxonomy, Geobotany/Ecology, Physiology/Biochemistry, Phytochemistry, Genetics, and Anatomy/Morphology. Additional programs are being developed in Plant Introduction/Acclimatization and Landscape Gardening. The campus has an area of 30 hectares, the adjoining garden, 300 hectares (plus the Arboretum's 1000 ha).

They are seeking to reconstruct forest vegetation in Guangdong Province along the highly eroded coastland. Work was begun in 1959 at a coastal site with typical lateritic soil and a climax tropical monsoon forest. The primary forest had been totally destroyed by human activity followed by over a century of erosion. The annual average depth of the surface soil here is 1 cm. The loss rate is $1000 \text{ m}^3/\text{km}^2$ annually.

Soil humus drops as low as 0.6%. The improvement procedures are:

- 1) Plants resistant to drought and tolerant of low soil fertility--Pinus massoniana and Eucalyptus exerta are planted. A primary cover was set up on 433 ha of barren eroded land.
- 2) Multistory mixed broad leafed vegetation are introduced on the land.
- 3) Tropical crops and fruit trees are introduced. Follow-up studies revealed the following changes:
 - a. During the transition from pure Pine-Eucalyptus to broad-leaf mixed forest types, biotic diversity and complexity appeared spontaneously, including the appearance of insects, birds, soil animals and soil bacteria.
 - b. Annual temperature fluctuation decreased from 14.3°C to 13.0°C; the relative humidity rose from 83.2% to 87.3%.
 - c. Soil loss declined by over 90% and the water table rose by 1.1 meters.
 - d. Soil pH rose from 4.5 to 5.7
 - e. Humic content rose from 0.76% to 1.13%
 - f. In the area, rice production rose 14-fold

They have also shown that the epidermis can significantly increase the photosynthetic efficiency (Brassica, Cerastium, Petunia, Talinum); the photosynthetic capacity in Amaranthus tricolor (C₄) is higher than in other grains or vegetable amaranths, but lower than that for a weed, A. palmeri; in Carica papaya the maximum net photosynthesis rate and leaf conduction declined with age while intercellular CO₂ concentration rose; leaf reflectance and absorptance changed as leaf chlorophyll and chlorophyll a/b ratio changed with age in C. papaya; and the efficiency of water usage declined linearly as the vapor pressure deficit increased (this work implies that estimates of stomatal conductance are important in understanding the limiting factors in photosynthesis).

Recent work of a more basic physiological nature on photosynthesis in papaya has placed this species in the category of "C₃ plants" (lack of bundle sheaths, low

PEP carboxylase activity, high glycolate oxidase activity, O_2 inhibition, etc.). The workers in these areas of photosynthesis make use of a Hitachi Plant Assimilation Analyzer, A LICOR Photosynthesis Apparatus, Beckman DU-7 and Pye Unicam SP8-500 Spectrophotometers.

The study of chilling injury in *Hevea* rubber plants has a high priority. One of their more interesting observations is that free ammonia accumulates in plants at prolonged sub-optimal temperatures. Other tropical/sub-tropical plants studied include cucumber, agave and rice. In cucumber, after a chilling treatment, electron transport and substrate oxidation first increased, then decreased. A chill-tolerant cultivar became metabolically stabilized after two days of a chilling treatment, but a chilling sensitive cultivar continued to decline. In several species, peroxidase in chill-tolerant cultivars characteristically had more isozyme bands than were seen in the non-tolerant forms; chill-tolerant cultivars responded more to exposure than non-tolerant by increases both in the total enzyme activity and number of isozymes. Esterase isozymes were less sensitive as indicators of tolerance than were the peroxidases.

Foliar senescence in rice has been investigated with emphasis on oxidative processes. With decreasing chlorophyll content, superoxide dismutase and RUBP-carboxylase activities both decline, but malonic dialdehyde increased. The latter is a product of lipid peroxidation. In more vigorous rice hybrids these changes are much less marked. These findings support the concept that oxygen radical species figure importantly in senescence. Other studies seek to elucidate the role of superoxide dismutase in the loss of seed viability during storage, especially in oil seeds.

As is the case in other institutions in South China, a sharp distinction is drawn here between biochemistry (essentially metabolism) and phytochemistry (special plant products, including medicinal principals). The anti-tumor constituents of *Cephalotaxus olivaei* are being studied in phytochemistry. Three alkaloids harringtonine, cephalotoxine and Schelhammera Compound B have been isolated by the phytochemistry group. Harringtonine, a complex DOPA derivative, inhibited a mouse sarcoma 42% at 1 mg/kg body weight and was highly active in acute non-lymphoblastic leukemia.

Natural sweeteners from *Rubus* species have been identified as a diterpene glycoside, M.W 600, and are 200-times sweeter than sucrose. Additional phytochemical

projects deal with Chinese medicinal plants and fragrance chemistry especially in Narcissus spp.

Plant Genetics is concerned with hybrid vigor and the application of tissue cultures and isozymal variation to the screening of hardy, vigorous, and resistant species, varieties and individuals. Work on senescence already noted interfaces nicely with biochemistry and genetics.

The Institute has a herbarium with 600,000 specimens and a sizeable library. In addition to 40,000 volumes, there are 600 foreign journals and 300 in Chinese.

The Institute's Botanical Garden founded in 1958, employs 150 people, 25 professionals, on grounds totalling 400 hectares. There are 4000 species of plants.

Among its special collection are 400 tropical monsoon species; 180 palm species; Haunan Island flora, and medicinals (about 300 species).

Among the more interesting specimen introductions are Ardensonia sp. (W. Africa), Triplaris (Cuba), a 20-25 meter tree in the Polygonaceae; Podocarpus fleuryi 15 meters tall, Cryptostrobus pensesis (water pine) and Gnetum sp.

9. South China Agricultural University, Wushan, Guangzhou:

This academic institution is not part of the Academica Sinica, and had not been originally scheduled for a visit. One of its faculty, Professor Xiao, attended our lectures and extended the invitation from the departments of Agricultural Biology and Horticulture (Professor Huang).

The School was formed as a college in 1952 out of the merging and reorganization of Sun Yat-Sen and Lingnan Universities. There are 10 academic departments--Agronomy, Soils and Agricultural Chemistry, Plant Protection, Forestry, Animal Husbandry and Veterinary Medicine; Horticulture, Agriculture mechanization, Sericulture, and Biological Sciences (= Plant Physiology and Biochemistry).

A centralized laboratory facility of over 4000 square meters of floor space includes transmission electron microscopy (800,000 x 1.5 Å resolution), scanning electron microscopy (200,000x), a seed and insect irradiation facility being installed for an 0.8 curie

⁶⁰C source; a Perkin-Elmer Atomic Absorption spectrophotometer and many of the same basics already noted elsewhere.

Near the campus is a 400 hectare experimental farm used both in teaching and research.

The library now houses over 500,000 books plus 120 periodicals in English, Russian, Japanese, German, or French (70,000 bound volumes). Thirty thousand volumes deal with ancient and traditional Chinese agricultures.

The teaching staff consists of 42 professors, 82 assistant professors, 440 lecturers and 147 teachers and assistants. The number of courses offered is somewhat over 200. The student body is now over 2000 and still increasing.

A number of professional faculty have served as "editors-in-chief" for many of the "Prescribed National Textbooks" of the Ministry of Agriculture. These are in fields of plant pathology, agriculture microbiology, physical chemistry and colloid chemistry, fundamentals of geology, silkworm pathology and many more. Others have served as assistant editors, thus adding to this University's impact on national agricultural education.

A cooperative program between the University and the College of Agriculture at Pennsylvania State University with joint USDA-China funding was inaugurated in 1980 for research collaboration in poultry science and vegetable diseases. Exchange of three professors from each institution has already been carried out. Funds for regional problems have also been provided by the United Nations (UNDP, FAO).

10. Conclusions:

When reviewing this all too brief visit to colleagues and institutions in Yunnan and Guangzhou, many specific thoughts and ideas pertaining to programs come to mind that would be better dealt with on a more personal level with the active principals. There are broader areas of consideration however, which can and should be brought before a wider audience both in China and the United States.

Attempts are now being made in China to conserve the traditional while national goals and needs call for extensive and timely modernization. That the results of this double value system are somewhat "patchy" will be a surprise to no one. Western life science has largely

avoided this situation by relegating traditions to the history books in all but rare cases. By and large, as an example, ethnic medicine is barely tolerated in United States. Times are changing for us, however, as the following shows: Klayman's article in the May 31, 1985, Science (v 228, p 1049) describes Qinghaosu (Artemisinin) which offers "promise as a totally new class of antimalarials. The compound from Artemisia annua has been known therapeutically since some time between the Han dynasty date of BC 168 and a handbook of emergency prescriptions from AD 340. And repeatedly, traditional Chinese ethnobotany and ethnopharmacology has provided the impetus for innovative work both in China and the United States.

The appreciation of medical botany may be best achieved by treating it as a living part of contemporary experimental plant sciences. The same may be said more broadly for the whole of natural products chemistry, long a step child of biochemistry in the West.

We saw in the South of China a determination to re-integrate instruction and research. To a large extent, this is only a statement of intent. Although we have numerous research-centered organizations in the United States, the most valuable and effective part of our life science establishment lies in the admixture of teaching and research. Although a blind "publish or perish" policy in universities is to be avoided, the expectation in our major universities to publish research papers as well as teach credibility may be a good model for China. One of the more important consequences of the (until recently) de facto segregation of instruction and research is over-compartmentalization of information and specialty. Although we in the West have long allowed a deplorable gulf to exist between systematics and ecology on the one hand and physiology and biochemistry on the other, plant physiologists are often engaged in biochemical work and conversely. The language is essentially the same. In China we saw the gulf extended to physiology and biochemistry of plants in a single institute, surprising even when physiology and ecology were well mixed in the same organization. Individual specialization is important, but excessive team involvement of the narrow specialist has often fostered productivity at the cost of creativity. A balance is possible, and the Chinese life science establishment should be encouraged to move toward the well-trained specialist whose training in the specialized areas rests upon a more multidisciplinary education.

We heard, and more than once, that the life sciences were not attracting young people the way engineering

does. This is understandable. The enormous tasks confronting China as the next 50 years call for enormous works. Engineers do visible things and the lustre of the builder, and being an engineer may even be patriotic in its appeal.

There is nothing pedestrian about life sciences research and development, but there is in the way they are offered to students (except for medicine, perhaps). We share this problem in the United States, but ways to attract student interest are emerging. One of these is to offer programs in "bio-technology". Programs that bring research into the high school (approximately Chinese middle school) for both students and teachers motivate people into research careers. The lack of interest in research by the general public is a problem in the United States, but far greater in China. The traditional Annual Science and Engineering fairs in the United States are novelties to all but the few Chinese scientists who had worked in United States cities. The United States also has successful high school level programs.

We encouraged Chinese scientists to reach out and extend to the young the opportunity to learn and work at serious science.

China can benefit from our experience with the various organizational facets of research and teaching from high school to career specialist. We in turn can learn the value of the paradigm of national support -- once having established national priority goals, these are supported to the maximum, even the more theoretical or abstract (or "academic"). Thus, having defined as a goal a 10-fold increase in Hevea rubber production, every aspect from "plantations as synthetic multi-storied ecosystems" to "the molecular botany of polyisoprenes" is justified. Of course institutes and universities and their executives, program directors and principal investigators must be knowledgeable and sensitive relative to information and technology transfer up the ladder of national needs.

One final comment about this brief view of South China. It has been increasingly proclaimed that mankind's future well being lies concentrated in the tropical belt. In China this is construed in terms of conservation, environmental protection, resource management, productivity and global ecological balance. In the United States, the tropics offer knowledge in pharmognosy, ethnopharmacology, ethnobotany, natural products, ecology, agricultural botany, horticulture.

Much more is to be gained by an especially close collaboration and intensive sustained interchanges of scientific and technical personnel cannot be overstated.

As we were told (as United States academics from Hawaii) by a young Chinese engineer in Hong Kong, "China is reaching out to you, especially people dealing with tropical plant science, for cooperation and help, and you can only disregard it to your detriment." We agree.

MEETING ANNOUNCEMENT

The Sixth Conference in Natural Sciences will be held at Hawaii Volcanoes National Park June 10-13, 1986. The program will be in the same format as in 1984. The conference will be preceeded by a three day workshop on "The control of introduced plants in Hawai'i's native ecosystems." The workshop will be followed by a day of contributed papers.

The tentative program for the workshop is as follows:

Perspectives
Status and Distribution of Some Important Alien
Plants in Hawai'i
Physical and Chemical Control
Biological Control
Agency, Organization and Landowner Approaches
Introduced Plants in the Absence of Ungulates
Integrated Pest Management and Ecosystem Approaches
Choosing which Plants to Introduce
Choosing which Plants to Control in Native
Ecosystems
Education and Community Action
Discussion and Summary

On the afternoon of Wednesday, June 11 there will be a field trip which will look at demonstration areas of chemical and mechanical control in Hawaii Volcanoes National Park, the insect quarantine facility, some special ecological areas in the park, and some alien plant problem areas including ungulate removal sites and recent burns.

Fliers and application forms will be available in February.

The proceedings of the contributed papers will be published by the CPSU/UH shortly after the conference. It is also hoped to publish the proceedings of the symposium.

OXALIS RUST IN HAWAII

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Honolulu, HI 96822

A rust disease is often observed on the clover-like garden weed Oxalis martiana common in Hawaii. The rust is recognized by the production of conspicuous, lemon-yellow sori on the under surfaces of leaves, sometimes with corresponding discoloration on the upper surfaces. Most infected plants are apparently not severely damaged, however. Oxalis regnellii, which rather closely resembles O. martiana but has larger leaves and white instead of pink flowers, may also become infected with the fungus. This plant is cultivated as a house or garden ornamental and is sold by local nurseries as shamrock prior to St. Patrick's Day. The disease is therefore of some commercial importance since infection destroys the aesthetic value of plants and prevents their sale.

Previous reports of oxalis rust in Hawaii (all unpublished) have referred the causal fungus to the aecial stage of Puccinia sorghi, the uredinial and telial stages of which infect corn and may be of considerable economic importance. Oxalis spp. are also reported elsewhere to be the aecial hosts of two additional rust fungi, P. purpurea and P. andropogonis (Cummins 1971). The uredinial and telial stages of P. purpurea occur on sorghum in Hawaii, where they are of some importance, and are also very common on Johnsongrass (Sorghum halepense), a roadside weed. Puccinia andropogonis occurs on Andropogon spp. on the U. S. mainland, but is not known to be in Hawaii at present.

In an effort to distinguish among the rusts attacking oxalis in Hawaii, I have made numerous collections and observations of infected plants, but I have not yet found an aecial infection. Attempts to experimentally infect plants of O. regnellii, O. martinana, and O. corniculata (the smaller, yellow-flowered weed) with P. purpurea basidiospores from sorghum and Johnsongrass have not been successful. Like the uredinial sori observed on oxalis in Hawaii, aecial sori are reported to be yellow and conspicuous, leading to possible confusion between the two stages on casual observation (Le Roux and Dickson 1957). However, the presence of distinct, raised aecial cups which are easily observed on under leaf surfaces distinguish aecial from uredinial infections.

Observations of urediniospores, associated with infrequent double-celled teliospores, indicate that oxalis is the uredinal-telial host of the common rust in Hawaii rather than the aecial host. Inoculation tests have shown that the fungus is capable of repeated infection of oxalis leaves rather than requiring an alternate host. I therefore consider the fungus to be Puccinia oxalidis rather than the aecial stages of either P. sorghi or P. purpurea, both of which, based on my observations, are apparently rare or do not occur in Hawaii at all. Although P. oxalidis is widespread on the mainland, it has not been previously recognized as such in Hawaii.

The aecial hosts of P. oxalidis are reported to be members of the Berberidaceae (Arthur and Cummins 1962). I have not yet observed rust infection on the single member of this family in Hawaii, sacred bamboo (Nandina domestica). It is quite likely that P. oxalidis does not produce an aecial stage, but is perpetuated by the repeating uredinial stage in Hawaii.

Literature Cited

- Arthur, J. C., and G. B. Cummins. 1962. Manual of the rusts in United States and Canada. Hafner Publishing Co.; New York. 438 pp. plus Supplement.
- Cummins, G. B. 1971. The rust fungi of cereals, grasses and bamboos. Springer-Verlag; New York. 570 pp.
- Le Roux, P. M., and J. G. Dickson. 1957. Physiology, specialization, and genetics of Puccinia sorghi on corn and of Puccinia purpurea on sorghum. Phytopathology 47:101-107.

Minutes of the December 1985 Meeting

The President called the meeting to order at 7:30 pm. The minutes of the November meeting were read and approved. The treasurer's report was as follows:

Balance brought forward	\$2,530.43
Receipts	457.80
Expenditures	0.00
Balance as of 12/01/85	\$2,988.23

The election of officers for 1986 was not held because the slate of nominees had not been circulated.

The Plant-of-the-month speaker, Mr. Jim Barrows, spoke about Kawainui Swamp. The presidential address, give by Ms. J. Lewis, was on underwater botanizing in Taiwan and Hong Kong.

Respectfully submitted
Christa Russell

Minutes of the November, 1985 meeting

President Lewis called the meeting to order at 7:30 pm. The minutes of the October meeting were read and approved. The President again reminded members that the Newsletter Committee welcomes contributions such as articles or appropriate announcements for future issues of the Newsletter.

Dr. Abbott presented the slate of officers nominated for the 1986 executive committee. They were as follows:

President:	Jane Lewis, Botany Dept., UH
Vice-president:	Rylan Yee, Botany Dept., Bishop Museum
Secretary:	Christa Russell, Botany Dept., Bishop Museum
Treasurer:	Derral Herbst, U.S. Fish and Wildlife Service

Steve Montgomery, Conservation Committee member, gave an update on the proposed H-3 Freeway which would run through Halawa and Haiku valleys, and border Ho'omaluhia park. Hawaii's congressional members, the governor, and others support legislation that would exempt H-3 from all federal laws, past and future thus by-passing the federal courts which have ruled that all alternative routes must be examined and exhausted before federal funds can be used to construct a freeway through or bordering a park. Dr. Montgomery reported that the environmental studies for Haiku valley have not been completed and that this proposal was a last ditch effort by the state to get federal highway monies. The Senate Environment and Public Works Committee would be hearing testimony on the proposed legislation in early November. It was proposed, and approved, that Dr. Wayne Gagne represent the Hawaiian Botanical Society at the hearings.

Members were reminded to bring in plants or plant products for the next plant exchange which will be in December.

Steve Montgomery announced that the Conservation Council for Hawaii was sponsoring a program on November 13th. at McCully Library on the ecology of the feral pig in Hawaii.

The Plant-of-the-Month speaker, Mr. Joel Lau, spoke on Euphorbia haleleeleana which he had recently discovered in Kaluakauila gulch in the Waianae mountains. Previously this species was known from Kaua'i only. Joel reported that there were about 150 plants in the gulch, and that threats to the survival of these plants were fires, as a result of bombing in Makua valley, and rats, which consume the fruit.

The speaker of the month was Mr. Frank Sekiya of Frankie's Nursery whose talk was intitled "Some Interesting Tropical Fruit Trees." Mr. Sekiya brought many different kinds of fruit which have been introduced into Hawai'i, and members were invited to somple the fruit after a most informative talk.

Respectfully submitted,
Christa Russell, Secretary

THE HAWAII HERITAGE PROGRAM

From the coastal dunes of Kure to the alpine ecosystems atop Mauna Kea, Hawai'i's natural heritage includes a remarkable array of plants, animals and ecosystems found nowhere else in the world. However, over two centuries of agriculture, urbanization and industrial development have changed the islands' landscapes. Today, much of Hawai'i's unique ecological inheritance survives in small, scattered and vulnerable fragments throughout the state. As Hawai'i plans for economic development and population growth, we need to find ways to balance our growth with our need to conserve our irreplaceable natural resources. The Nature Conservancy's Heritage Program is designed to provide the information needed to work towards that balance.

The goal of the Hawaii Heritage Program is to establish a centralized, comprehensive, up-to-date source of information on the rare species and ecosystems in Hawai'i. Use of this statewide data base offers three advantages to land use planners: (1) Potential environmental concerns can be identified before extensive financial commitments have been made. (2) Environmental permit and review requirements can be completed more rapidly, reducing "red tape" and expense. (3) Public and private organizations can pool their resources to support a single, reliable source of biological information, avoiding expensive duplication of effort. The Hawaii Heritage Program is supported through fee-for-service arrangements with public and private users.

FOSTER GARDEN EVENTS

March 27-30	Lana'i: Field trip
April 19	Spring Plant Sale
May 23-26	Hawai'i: Advanced ecology camp/field trip
June 13-15	Moloka'i: Topside field trip

STATUS OF ENDANGERED HAWAIIAN PLANTS
April 30, 1985

Taxa listed as endangered:

Bidens cuneata Sherff
Euphorbia skottsbergii var. kalaeloana Sherff
Gouania hillebrandii Oliver
Haplostachys haplostachya var. angustifolia (Sherff) St. John
Kokia cookei Deg.
Kokia drynarioides (Seem.) Lewt.
Lipochaeta venosa Sherff
Panicum carteri Hosaka
Schiedea adamantis St. John
Stenogyne angustifolia Gray var. angustifolia

Taxa proposed for listing:

Abutilon menziesii Seem.
Achyranthes splendens var. rotunda Hbd.
Proposed 22 Apr. - as A. rotundata
Argyroxiphium sandwicense var. sandwicense (DC.)
Gardenia brighamii Mann
Hibiscadelphus distans Bishop & Herbst
Santalum freycinetianum var. lanaiense Rock
Scaevola coriacea Nutt.

Taxa presently being reviewed by the Washington, D.C. Office as candidate endangered species:

Cyanea superba (Cham.) Gray
Mezoneuron kawaiense (Mann) Hbd.
Remya mauiensis Hbd.

Taxa with completed status surveys:

Adenophorus periens Bishop
Alectryon macrococcum Radlk,
Brighamia spp.
Drypetes phyllanthoides (Rock) Sherff
Dubautia latifolia Carr
Dubautia latifolia (Gray) Keck
Geranium arboreum Gray
Isodendrion hosakae St. John
Munroidendron racemosum (Forbes) Sherff
Santalum ellipticum var. littorale (Hbd.)

The Endangered Species Act requires the U.S. Fish and Wildlife Service to conduct a review of all species listed as threatened or endangered at least once every five years. The purpose of this activity is to update the status of the species to ensure that the list is as accurate as possible. The official notice of review was published in the Federal Register in the July 22, 1985 edition, pages 29900-29909. This notice concerns the review of status of those species classified as threatened or endangered before 1976 and in 1979 and 1980. Species from the Pacific region include two mammals, 38 birds, three reptiles, and four plants.

If members of the Society have comments regarding any of these plants or animals, please send them to Dr. Herbst whose address is listed below. If you have any questions please call Dr. Herbst at 546-7530.

Dr. Derral Herbst
U. S. Fish & Wildlife Service
300 Ala Moana Boulevard
P.O. Box 50167
Honolulu, HI 96850.

REFRESHMENTS

Our refreshment fund is in the red! Zella Ellshoff is doing an outstanding job providing for our enjoyment after the talk each meeting. However, the cost of everything is going up and we are no longer able to meet the cost of providing refreshments under the present arrangement. Donations toward the cost of refreshments, either in cash or kind, would help to alleviate the problem.

PLANT EXCHANGE

Due to the popularity of the plant exchange we will try and hold it three times this year. The scheduled exchanges will take place at the March, June and December meetings.

For those of you bringing material to exchange, we are interested in any plants, other than weeds. We ask that you provide a name with your plants and if they are unusual a short discussion on some of their interesting attributes. Please remember that many of our members do not have gardens so material suitable for apartments and lanais is also welcome. Others are just starting their gardens so bananas, taros, mountain apples, etc., are useful. If you cannot bring the plant, some of the fruit for members to try is also welcome.

EXTENSION OF INFESTATION OF
DIAPORTHIOPSIS METROSIDERI TO BIRD PARK

F. R. Fosberg
Botany Department
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560

In a recent issue of this Newsletter (22:13-16, 1983) I summarized what is known of the ecology, pathology, and distribution of Diaporthiopsis metrosideri Roane and Fosberg (Endothia metrosideri (R. & F.) Barre), distributed roughly from Kipuka Nene to Kilauea Iki and Volcano Village.

Because of its apparent pathogenicity to the most important Hawaiian tree species, it seems of interest to report even small extensions of its range. On March 26, 1984, I investigated a small area of open Metrosideros forest just outside the entrance to Kipuka Puaulu (Bird Park), Hawaii Volcanoes National Park, that showed a number of dead trees and others that seemed in poor condition. Four recently dead trees exhibited the characteristic lumpy black fruiting bodies of Diaporthiopsis metrosideri, pushing out of cracks in the bark, Fosberg 64306 (BPI, BISH)).

In view of the ecological importance of its host tree it seems urgent to undertake an intensive effort to determine the full geographic range of the fungus, whether or not it is spreading, the mechanism of its dispersal and establishment, details of infection, and the precise degree of its parasitism. This would seem to be a task for an experienced forest pathologist, and to merit serious attention from the research authorities of the National Park Service, as well as from the Hawaii State Forester. This infestation may already be on the way to becoming a major problem in the moist and semi-dry 'Ohi'a-lehua forests of Hawai'i.

I wish to thank the Pacific Tropical Botanical Garden for making it possible to visit Hawai'i and to continue observation of this fungus.

VENUE FOR SOCIETY MEETINGS

The Hawaiian Botanical Society will hold its meetings this year in the old Hawaiian Sugar Planters Association building, now the Arts and Crafts Building in Makiki Park. The meetings will be at the same time and dates as previously, that is, the first Monday of the month except July, August and September.

This year marked the 61st year of the Hawaiian Botanical Society.

Conservation issues: Society members were asked to write their Congressional delegation and the National Park Service to pursue acquisition of Campbell Estate tract 22 at Kahauale'a, which had been targeted for geothermal exploratory drilling. Kahauale'a is adjacent to Hawai'i Volcanoes National Park and includes pristine 'ohi'a forest. Management recommendation for the rare Marsilea villosa were sought from the Society by the Honolulu City Council. Dr. Wayne Gagne represented the Society at hearings in Washington before the Senate Environment and Public Works Committee on proposed legislation to exempt the proposed interstate highway H-3 from all federal laws, past and future. The Society has gone one record against the passage of such legislation.

Members enjoyed a joint field trip to Lyon Arboretum and Manoa Falls with members of the Hawaiian Entomological Society on May 25. April and December were plant exchange months.

The Hawaii Science and Engineering Fair awards were increased to \$200 but subdivided into smaller awards. Seven projects in this years' fair received awards.

The Society offer to participate in planting native trees as part of the "Million Trees of Aloha" program sponsored by the Governor's wife and the state Department of Land and Natural Resources.

Three issues of the Newsletter were published this year containing a total of 96 pages.

The speakers at this years' meetings were:

January	Mr. E. Eby - Cactus and Succulent Society Cacti and succulents
February	Dr. M. Littler - Smithsonian Institue Deep-water algae
March	Dr. R. Nishimoto - Horticulture UHM Recent developments in control of weeds
April	Dr. P. Weissich - Honolulu Botanic Gardens Honolulu botanical gardens - an update
May	Dr. H. St. John - Bishop Museum Recent History of Botany in Hawaii (1835-1871)
June	Dr. D. Talbot - Hawaiian Paradise Nursery Bromeliad in Hawai'i
October	Mr. S. Nims - Trees of Hawaii Tree pruning standards
November	Mr. F. Sekiya - Frankie's Nursery Some interesting tropical fruit trees

December Presidential address by Ms. J. Lewis
 Botanizing in Taiwan and Hong Kong
 Respectfully submitted
 Christa Russell, Secretary

TREASURER'S REPORT

December 1, 1984 - November 30, 1985

Receipts:

Dues	\$878.50	
Life memberships	600.00	
Gifts	120.00	
Interest	<u>967.08</u>	
		\$2,565.58

Expenditures:

Postage	\$206.05	
Newsletter publication	665.86	
Science Fair expenses	207.28	
Copying charges	<u>20.48</u>	
		\$1,099.67

Cash flow		\$1,465.91
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Net worth of Society:

December 1, 1984	\$17,213.97
Change: 12/01/84-11/30/85	<u>1,465.91</u>
November 30, 1985	\$18,679.88

Bank balances:

Honolulu Federal S & L - checking account	
Balance 12/01/84	\$2,361.43
Balance 11/30/85	<u>\$2,988.23</u>
	\$626.80

First Federal S & L - Acct. #111764	
Balance 12/01/84	\$491.81
Balance 11/30/85	<u>\$519.60</u>
	\$27.79

First Federal S & L - Acct. #C-718689	
Balance 12/01/84	\$13,360.73
Balance 11/30/85	<u>\$15,172.05</u>
	\$811.32

Bank balances as of 11/30/85	\$18,679.88
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Changes in balances 12/01/84 - 11/30/85	<u>\$1,465.91</u>
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Respectfully submitted
 Derral Herbst

Audited and found correct: W. Bush.

NEWSLETTER
HAWAIIAN BOTANICAL SOCIETY
C/O DEPARTMENT OF BOTANY
UNIVERSITY OF HAWAII AT MANOA
3190 MAILE WAY
HONOLULU, HI 96822

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Newsletter

Hawaiian Botanical Society



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Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

OFFICERS OF THE HAWAIIAN BOTANICAL SOCIETY 1986

Executive Council

President: Jane E. Lewis, University of Hawaii
Vice-President: Rylan N. S. Yee, Bishop Museum
Treasurer: Derral Herbst, U.S. Fish and Wildlife Service
Secretary: Christa Russell, Bishop Museum
Directors: Evangeline Funk, University of Hawaii
Dan Palmer, University of Hawaii
Isabella Abbott, University of Hawaii

Committees (appointed by the Executive Council)

Membership: Karen Asherman, Chair
Newsletter: Isabella Abbott, Chair
Clifford Smith, Editor
Conservation: Elizabeth Powell, Chair
Art Medeiros, Maui
Science Fair: William Brostoff
Alvin Yoshinaga
Native Plants: Clifford Smith, Chair
Ken Nagata
Evangeline Funk
John Obata
Art Medeiros, Maui
Publicity: Marilyn Cannon, Chair

HAWAIIAN BOTANICAL SOCIETY MEETING
Minutes of the February 1986 meeting

Vice-president Yee called the meeting to order at 7:40 p.m. Minutes of the December meeting were read and approved.

The chairman for the Membership Committee reported that notices for 1986 dues would be out soon, and Dr. Abbott announced that the first issue of the 1986 Hawaiian Botanical Society Newsletter was available at the meeting.

Elections were held for the 1986 Botanical Society officers. They are:

Vice-president:	Rylan Yee
Secretary:	Christa Russell
Treasurer:	Derral Herbst
Directors:	Isabella Abbott
	Evangline Funk
	Dan Palmer

Bill Bush reported that an audit of the Botanical Society's financial accounts showed them to be correct.

Under new business there was some discussion on a proposed amendment to the Hawaiian Botanical Society Constitution to allow the President, or the Vice-president of the Society to succeed himself or herself in office. The amendment proposed by Bill Bush and Isabella Abbott reads as follows:

Article IV. Officers

Strike: Section 4. The President or Vice-president may not succeed himself in office except as hereinafter provided. (By-laws Art. IV--duties of Vice-president).

Renumber: Sections 5, 6, and 7 of Article IV to become sections 4, 5, and 6.

By-laws. Article IV. Officers.

Paragraph 2, last sentence: Strike: He is not thereby rendered ineligible for a full term as President (See Constitution Article IV, Section 4).

Also under new business Carolyn Corn announced that the Natural Resources Defense Council is encouraging plant conservation societies to submit applications for endangered species research. Dr. Corn said that funds are available for helicopter reconnaissance of Acacia koaia on Pu'uwa'awa'a to determine an area to be set aside for a proposed natural area reserve. Interested individuals can contact Dr. Corn at the State Department of Land and Natural Resources.

Vice-president Yee asked members to let him know their feelings about the Society meetings being held at the Makiki Park Arts building.

Speaker of the Month was Dr. Gerald Carr, U.H. Department of Botany, whose talk was entitled "Everything you always

wanted to know about silverswords but were afraid to ask because you knew he would go on, and on, and on." Dr. Carr gave us a richly illustrated overview of his recent monograph of Agyroxiphium, Wilkesia, and Dubautia.

Respectfully submitted,
Christa Russell, Secretary.

Minutes of the March 1986 meeting

Vice-president Yee called the meeting to order at 7:40 p.m. Minutes of the December meeting were read and approved. Dr. Herbst reported that the March balance in the Society treasury was \$2661.16. There were no committee reports.

Under old business the Constitutional amendment to allow the President or Vice-president to succeed himself or herself in office was approved, and Jane Lewis was elected president of the Society. Also under old business there was some discussion on meeting at the Makiki Park Arts building and the general consensus was to continue holding meetings there through the end of the year.

Plant of the Month speaker was Dr. Warren Wagner of the Bishop Museum Botany Dept. Dr. Wagner spoke on Spermolepis hawaiiensis, one of the few native Apiaceae found in Hawaii. This taxon, collected only seven times since Capt. Cook, was thought to be extinct until it was recently collected on Maui by Bob Hobdy.

Speaker of the Month was Dr. Wayne Gagne, Bishop Museum Education Dept., whose talk was entitled "Feral pigs, wallows and digs: the impact of feral pigs on the Hawaiian environment." Dr. Gagne presented an indepth view of the damage to Hawaiian ecosystems, for example, bogs which had been "rototilled" by pigs, and the secondary impact of such on native Hawaiian fauna.

The meeting was adjourned at 9 p.m. and members then enjoyed refreshments and plant exchange.

Respectfully submitted,
Christa Russell, Secretary.

Minutes of the April 1986 meeting

President Lewis called the meeting to order at 7:35 p.m. Minutes of the March meeting were read and approved. The treasurer's report was read, the balance at the beginning of April was \$2,708.97.

For the membership committee, President Lewis reported that the membership list will be transferred to the Wang computer at the Bishop Museum.

For the Newsletter committee, Dr. Abbott reported that the latest Newsletter is pending, and that the Newsletter committee is looking for a "news collection" person.

Under new business it was announced that horticultural displays by the Garden Club of Hawaii would be shown at the Honolulu Academy of Arts April 12-13. It was also announced that the Society had bought a tape recorder to record the monthly speakers.

Plant of the Month speaker Marie Brueggmann spoke on Marsilea villosa, a rare water-fern which occurs on Koko Head, and is threatened by off-road vehicles and exotic weeds such as Panicum maximum and Merremia sp.

Speaker of the Month was Dr. Bill Magruder whose talk was entitled "The Sex Life of a Red Alga." Dr. Magruder presented an interesting and informative talk, illustrated with scanning electron micrographs, on the peculiar life cycles of red algae.

The meeting was adjourned at 9 p.m. and members then enjoyed refreshments.

Respectfully submitted,
Christa Russell, Secretary.

Minutes of the May, 1986 meeting

President Lewis called the meeting to order at 7:35 p.m. Minutes of the April meeting were read and approved. The treasurer's report was presented:

Balance brought forward:	\$2,708.97
Receipts:	
Interest	\$12.14
Expenditures:	
Postage	\$109.00
Science Fair prizes	<u>\$215.00</u>
TOTAL EXPENDITURES	\$324.00
Balance at the end of April	\$2,397.11

Under new business President Lewis announced that the winners of the Botanical society's Science Fair awards were as follows:

Best botanical project and best botanical intermediate project: Ward Kishimoto (8th grade), "The use of algae to compare nutrient levels of Oahu streams".

Best botanical senior project: Kara Okahara (12th grade), "Organogenesis as responses of in-vitro propagated Cucurbita domestica".

Five other students received awards for outstanding botanical projects.

Speaker of the Month was Audrey Newman, who spoke on the Hawaii Heritage Program of the Nature Conservancy. One of the goals of the Heritage Program is to compile a database on rare plants of Hawaii and to make this information available for wise land management and planning. The present focus of the Heritage Program are rare plants found in the Honouliuli Forest Reserve in the southern Waianae.

The meeting was adjourned at 9 p.m. and members then enjoyed refreshments.

Respectfully submitted,
Christa Russell, Secretary

Congratulations to MARIE BRUEGMANN on finishing her Master's thesis on "A Partial Study of the Phenology, Tissue Water Relations, and Taxonomy of Marsilea villosa." Marie studied the field biology of Marsilea in the swale southeast of the right shoulder of Hanauma Bay (if you're looking out to sea from the Bay). The only other "patch" she knows on this Island is at Lualualei Naval Ammunition Depot. Earlier records show it to have been in some taro patches. If you see an aquatic "four leaf clover", bring it in--we might be able to increase the range of this species since it is having a very hard time holding its own against motorcycles, 4-wheel vehicles, and the like at Hanauma Bay. Marie is looking for a job; she's a trained taxonomist.

The city of Honolulu, through the Mayor's office, has announced plans for the development of Kipapa Gulch (between Pearl City and Wahiawā). Older members of the Society will remember that the ecology and flora of the Gulch is one of the best/early base-line studies of Hawaiian vegetation. It was prepared by Edward Y. Hosaka, as a student of Dr. St. John, and is published in the Bishop Museum Occasional Papers XIII (17): 175-232, 1937. It contributed important information to "Vegetation Zones of Hawaii" by J. C. Ripperton and E. Y. Hosaka as HAES Bulletin No. 89 (1942). A present-day ecologic study of the vegetation in the Gulch would be extremely interesting, and should perhaps be suggested prior to bulldozing and conversion to golf courses and tennis courts which are anathema to plant communities.

STAND STRUCTURE OF AN ISOLATED FOREST
IN LYON ARBORETUM, 'O'AHU, HAWAII

Mary Grady
Department of Geography
University of Hawaii at Manoa
Honolulu, HI 96822

INTRODUCTION

Islands have always been important in the study of biology and geography. Since Darwin, the special influence of the island environment on organisms has been recognized. More recently, with the work of MacArthur and Wilson (1967) on the nature of species-area interactions, research in island biogeography has been stimulated in new directions.

Terrestrial ecosystems can also be considered "islands" under certain circumstances. For example, the tops of high mountains have often been compared to islands, as they represent an isolated area where organisms must adapt to a habitat isolated by environmental gradients.

As the natural landscape becomes more and more disturbed by human activities, ecologists have realized that terrestrial forest islands are being created (e.g., Burgess and Sharpe, 1981). Where once there were large continuous forests, there now remain patches of trees, isolated from one another by urbanized and developed areas. Many questions are raised by this situation--can these patchy forests reproduce and sustain themselves adequately? What will be the result of increasing the ratio of edge to total area? How will the structure and species composition of the forest change?

These questions are particularly urgent in the tropics. Vast tropical forests are being destroyed at high and still accelerating rates (Osterlund, 1985). If representative areas of the forest are to be preserved, it is important to understand the effects of converting a continuous canopy to isolated patches. What is the minimum critical size of a forest reserve, if the original species diversity is to be maintained? What is the maximum distance a small area can be from a larger "source" area, to benefit reproductively? Is it more effective to preserve scattered small areas, or a single large one?

This field study concentrates on a small patch of forest isolated within an intensively human-managed landscape. The objective is to analyze the present structure of the stand, and to determine the population dynamics. Is the stand in equilibrium, is it in a successional stage, or in a transitional stage, where exotic species are invading? While this small study can't begin to address the complex questions of forest island dynamics, it may serve to illustrate them at the microscale.

THE STUDY AREA

A site was chosen on the grounds of the Lyon Arboretum, in upper Mānoa valley on the Hawaiian island of O'ahu. The arboretum has been operated by the University of Hawaii since 1953. Prior to that time, most of the land was deforested for agriculture and pasture, with some of it used for experimentation by the Hawaii Sugar Planters Association. Since the 1950's, the arboretum has been managed intensively for botanical research and education. The arboretum encompasses 124 acres at the top of Mānoa Valley, following along the Aihualama Stream, and rising up steep slopes to 1,600 feet.

The climate is humid and tropical. It rains nearly every day, though dry spells do occur and vary in length and season. The area is within typical rain forest environment. The average rainfall is about 4,000 mm a year. The frequent cloud cover probably maintains lower temperatures than expected from reference to figures from stations at the mouth of the valley.

The study site (Figure 1) consists of a small unmanaged patch of forest that runs along a ridge, with valleys on either side. The field sketch (Figure 2) shows the site, looking upslope. To the left is small shady swale with moister soil. This study concentrated on the ridge area. The other three edges of the forest patch are clearly evident. To the right side of the trail, the land drops off steeply and is cleared of undergrowth. Above and below the site the vegetation is well-cleared.

In the 1920's, sugar cane was planted in this area, but was discontinued in the late 1930's. The only management within the patch since then was the felling of a few large Albizzia in the late 1960's and occasional herbicide applications against orchid grass, which should not affect the trees. Also, some Citharexylum caudatum has been sprayed or destroyed occasionally. (Ray Baker, personal communication).

Soils here are classified as "Tantalus silt loam" (Foote, et. al., 1972). This is a well-drained upland soil developed from volcanic ash and weathered cinders. The soil was observed to be very fine, quite deep and uniform, with no surface stones or outcrops. It is a deep reddish-orange color.

The hillside slopes at about 20 degrees, and the forest patch ranges from 150 to 180 meters elevation. The slope faces roughly northeast, and continues rising above the study site for about another 60 meters. Below the site, at about 120 meters, there is a well-used service road/trail. The land drops off sharply below the road to the stream at the bottom. The area between the road and the site is grassy with

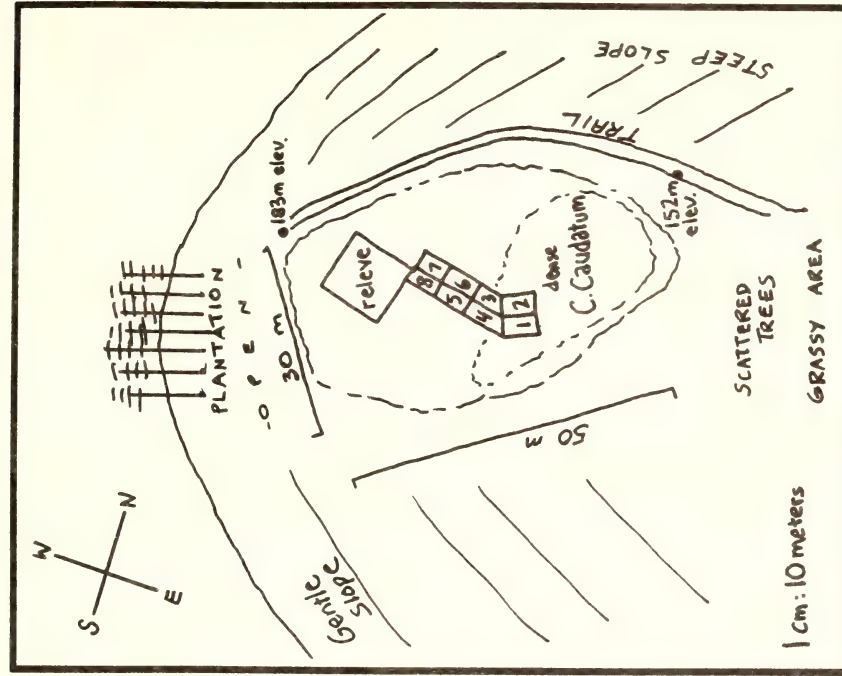


Figure 2. Relevé and transect placement at the study site in Mānoa Valley, O'ahu, Hawai'i.



Figure 1. Location of the study site in Mānoa Valley, O'ahu, Hawai'i

scattered trees. Birds were plentiful on the site, but no pig damage was apparent.

METHODS

The method used for analyzing the stand structure was a count-plot transect, 6 x 20 meters (120m^2). As the entire stand covers an area of only about 1500m^2 , this represents an 8% sample. A 10 x 10 m relevé was also evaluated, to help provide a general description of the forest structure. Both methods followed techniques described by Mueller-Dombois and Ellenberg (1974).

The relevé was situated at a point about halfway up the slope, and as far into the interior of the stand as possible, in an effort to minimize the effect of edge. Emphasis was on describing the physiognomy of the site, and species that occurred at a frequency below 1 on the Braun-Blanquet scale were omitted.

The count-plot transect ran downhill from a bottom corner of the relevé. At 15m it swerved 30 degrees to the west to avoid getting entangled in a dense Citharexylum caudatum thicket. All tree species rooted inside 3 X 5m sub-plots along the 20m tape were counted individually. Each tree was measured with calipers for basal diameter, and the heights were estimated. When the Citharexylum saplings were too dense, individual measurements were eliminated, and instead the trees were counted according to class (less than 3cm and 4.5m). A large fallen tree was under the tape at about the halfway point.

RESULTS

The relevé data (Table 1) shows that this small forest contains six stratified layers of vegetation. However, these layers were not very clearly delineated, but rather a continuum of plants of all sizes. The understory in the relevé was relatively open and easy to move around in.

The count-plot transect began 20 meters downslope from the relevé and moved upslope (see Figure 2). In the lowest plots Citharexylum caudatum was very dense. The Citharexylum gradually thinned out and was smaller in height higher up the slope, until by the last count-plot there were only a few small seedlings. The plots (Figure 3) of Citharexylum density show the rapid decline in density. Citharexylum caudatum (fiddlewood) is an introduced tree, and is considered a pest.

The second most abundant species, Cordyline terminalis (ti), was introduced by the Hawaiians, and is important in native culture. Its distribution (Figure 3) becomes more abundant as Citharexylum thins out. This could be a sign that Citharexylum is crowding out the ti plants.

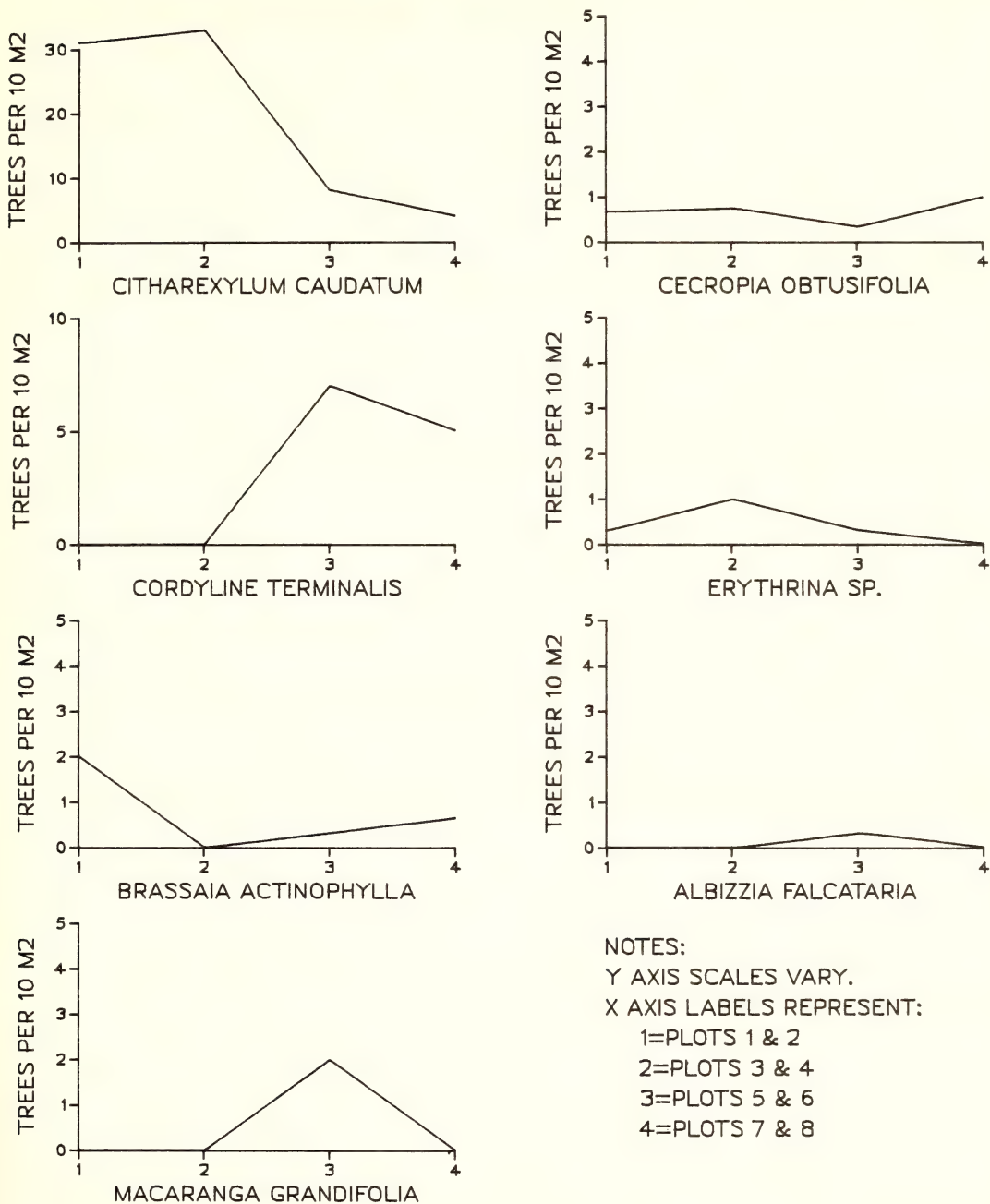


Figure 3. Tree density/10m² along the transect in the study area, Mānoa Valley, O'ahu, Hawai'i.

Table 1. List of species by layers and quantities in a mixed forest community at the Lyon Arboretum, Mānoa Valley, O'ahu, Hawaiian Islands.

Layer	Quantity*	Species	Life-form
Ground	3	<u>Oplismenis hirtellus</u>	Th
	3	<u>Dryopteris</u> sp.	Fern
	2	<u>Nephrolepis hirsutula</u>	Fern
S2	2	<u>Nephrolepis hirsutula</u>	Fern
	2	<u>Citharexylum caudatum</u>	Ph
S1	1	<u>Brassaia actinophylla</u>	Ph
	1	<u>Citharexylum caudatum</u>	Ph
	1	<u>Cordyline terminalis</u>	
T3	2	<u>Citharexylum caudatum</u>	Ph
	2	<u>Cordyline terminalis</u>	Ph
T2	2	<u>Citharexylum caudatum</u>	Ph
	1	<u>Cecropia obtusifolia</u>	Ph
T1	1	emergent trees rooted outside relevé	

*Quantity assessed by Braun-Blanquet method.
Species with less than 5% cover omitted.

The other tree species, except for Cecropia obtusifolia, show a patchy distribution along the transect. These results indicate the presence of diverse microhabitats within this small forest, or perhaps interspecific competition. More detailed studies would be required to determine the true causes of the patchy distribution shown by the transect charts.

Density and dominance relations for the tree species (Tables 2 and 3) show that Citharexylum is by far the most abundant plant and ti is second, with all the others quite low in number. However, the dominance table reveals very different relationships. Albizia falcata, represented by only one very large tree in the sample, is clearly dominant in stem cover. Cecropia is second, with Citharexylum a strong third by virtue of its density, despite its small stem size.

The frequency relations (Table 4) reinforce the relationships demonstrated in the density table and the transect charts. Only Citharexylum shows 100% occurrence. The other tree species are found more or less in patches.

Distribution of species by size classes data (Table 5 and Figure 4) can be interpreted to describe the reproductive dynamics of the stand. Only Citharexylum and ti were recorded in sufficient numbers to be considered as showing significant trends, but some information can be inferred about the other species from the available data. Cecropia was counted only nine times, but in a wide range of size classes. This uniform distribution suggests that the species is well-established. The species may be maintaining itself or it may represent a low density cohort.

Albizzia, was counted only once in the sample, due to its widely scattered distribution in the forest. The absence of any small Albizzia indicated a lack of reproduction in the area. Erythrina occurs only in the smaller size classes. With no mature trees, it would seem to be a recent invader of the forest.

Macaranga grandifolia shows the most concentrated distribution. All individuals of this species occurred in one size class, and in only two sub-plots. This could be a chance invasion that happened at one opportune time. But a close look at the field data shows some variation in size--from 0.9 to 3.0 cm in diameter, and 1 to 6 meters high. So Macaranga may in fact be reproducing and establishing itself in the forest. An alternative explanation may be that the population represents two cohorts.

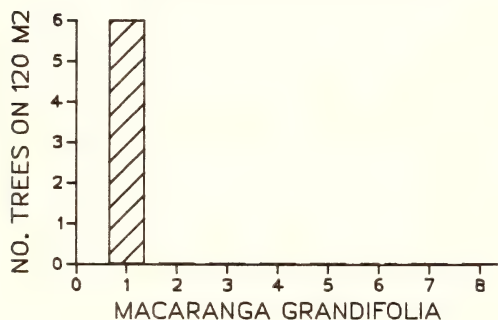
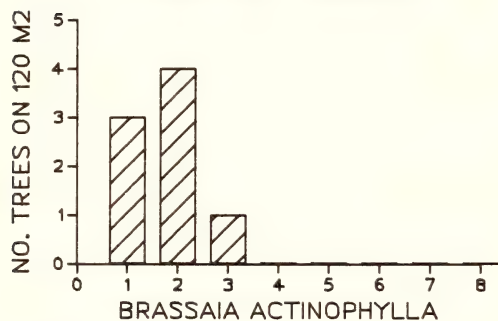
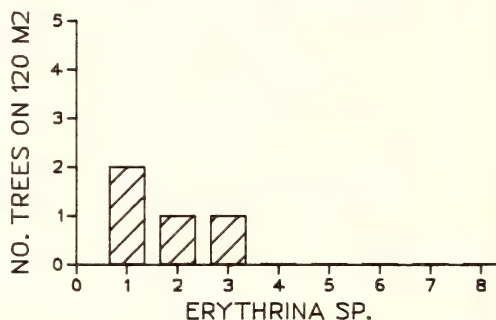
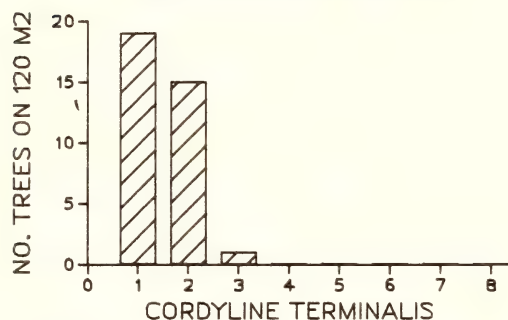
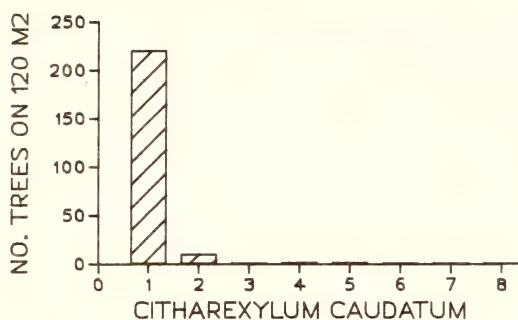
Brassaia actinophylla was found exclusively in the smaller size classes. However, the field data again shows a broad enough range to imply that it may be an establishable tree.

The population dynamics of ti must be understood according to the growth characteristics of the tree. Ti is naturally a smaller tree, seldom growing above 3 or 4 meters high, so its absence from the larger size classes has a different reason. The count-plot data shows a range of stem sizes (1.3 to 6.0) though all the heights are 4.5 meters or less. The larger trees can be considered mature in this case, indicating that ti is well-established and thriving.

Citharexylum, the most dense and abundant tree, demonstrated the size profile of an invading species. Large numbers of small and medium-sized plants, with no mature trees, show that it is relatively new to the forest and dispersing.

DISCUSSION AND CONCLUSIONS

A full explanation of the reasons for the distribution of species over space and time in this forest would require a much more thorough field study. For example, can the patchiness of Citharexylum and ti be attributed to environmental variation--such as differences in canopy cover



NOTES:
Y AXIS SCALES VARY.
X AXIS LABELS REPRESENT
SIZE CLASSES FROM
SMALLEST TO LARGEST
(1.5 TO 95.).

Figure 4. Size class distribution of various tree species in the study area, Mānoa Valley, O'ahu, Hawai'i.

or soil moisture--or does it signify that Citharexylum is simply still on its way into the area, and will eventually predominate?

Another important consideration in understanding the structure of this forest is the high ratio of edge to total area. Ranney et. al. (1981) found in their study in temperate-zone forests that edge effects penetrated into the forest interior to a depth of about 15 meters. If this is true in the tropical environment, then the whole study site might be considered an ecotone, with no real interior.

The presence of edge affects the forest structure in several ways. Edges tend to contain more species, and a higher component of shade-intolerant species. They support a greater basal area. They may modify the interior microclimate by blocking the wind, and can affect dispersal of propagules into the interior. Edges also change over time through successional stages (Ranney, et. al., 1981). In this study, the edge has been maintained over the growth of the forest as a whole. Can the whole site be described as "edge"?

Citharexylum is known to have been introduced into Mānoa only about 60 years ago (Merlin, 1977). How long it has been invading this particular site is uncertain. It's small size would imply that most of it is rather recent, especially when compared to the size of the huge Albizzia trees. Will it completely take over the area, or will it be unable to survive in the interior? Perhaps its failure so far to invade completely and uniformly suggests that the forest can not be considered as only edge after all.

Another question is whether a forest of such small size can maintain itself over time. Lovejoy and Oren (1981) postulate that ecosystems with an area decreased below "minimum size" will inevitably decay. Species will be lost due to critical genetic bottlenecks in the small populations, random fluctuations in population size, or because there are just not enough individuals to insure reproduction. However, this site developed as an island, it was never part of a larger forest. In that sense, it may be more appropriate to evaluate the species composition with reference to MacArthur and Wilson's theory of island biogeography.

According to MacArthur and Wilson, the number of species on an island will approach equilibrium as the rate of colonization decreases and the rate of extinction rises. The equilibrium number of species is mainly a function of island area. If this theory applies to the study site, then as Citharexylum colonizes, it should result in the extinction of another species (assuming that the "island" is sufficiently well-developed that it has reached its "saturation point").

But another factor in island development is distance from a source area. The arboretum is only 124 acres, and all around are steep forested slopes of what appears to be unmanaged forest. Are these forests providing colonization input? If so, is their influence strong enough to overcome the edge effects and small area and maintain the island as a forest like themselves?

All of these complex questions can be answered only by waiting to see how the site evolves over time. The results of this study have succeeded in raising these questions. And some conclusions can be drawn from the data.

It is clear that Citharexylum is invading the forest. Ti seems to be holding its own. The other species were sampled too infrequently reach a conclusion. It appears that the forest has developed both interior and edge microhabitats. Distribution of species within the forest is patchy. It's possible that Citharexylum and ti are competing species, as their distribution pattern is almost mutually exclusive.

The study of isolated forests in the tropics has important implications for conservation programs. Understanding the structural dynamics of small stands can help in planning for nature reserves to prevent extinction of unique forest ecosystems.

ACKNOWLEDGEMENTS

Mr. Bob Hirano of Lyon Arboretum introduced me to the study site. Mr. Ray Baker, also of Lyon Arboretum, helped with plant identification and provided aerial photos and information of the history and climate of the site. Dr. Dieter Mueller-Dombois of UH Mānoa Botany Dept. also helped with plant identification and suggestions for data analysis.

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Table 2. Mean number and Density of trees species in a mixed forest community at the Lyon Arboretum, Mānoa Valley, O'ahu, Hawaiian Islands.

Species	Count per 120 m ²	Density per 100 m ²
<u>Citharexylum caudatum</u>	232	193.3
<u>Cordyline terminalis</u>	35	29.2
<u>Brassaia actinophylla</u>	8	7.5
<u>Macaranga grandifolia</u>	6	6.7
<u>Cecropia obtusifolia</u>	9	5.0
<u>Erythrina</u> sp.	4	3.3
<u>Albizzia falcataria</u>	1	.8

Table 3. Total and Mean Basal Area for each tree species/120m² sample and Total Basal Area for each tree species/100 m² in a mixed forest community at the Lyon Arboretum, Mānoa Valley, O'ahu, Hawaiian Islands.

Diameter Class	Basal Area (cm ²)	Number of Trees x Basal Area						
		1	2	3	4	5	6	7
1.5	1.7	374	32.3	5.1	10.2	0	3.4	0
5	19.6	196	294	78.4	0	19.6	19.6	0
8.5	56.7	0	56.7	56.7	0	0	56.7	0
12.5	122.7	122.7	0	0	0	368.1	0	0
16.5	213.8	213.8	0	0	0	0	0	0
27.5	593.9	0	0	0	0	1187.8	0	0
32.5	829.6	0	0	0	0	2488.8	0	0
95.0	7088.2	0	0	0	0	0	0	7008.2
Total		906.5	351	140.2	10.2	4064.3	79.7	7008.2
No. of trees/ 120m ²		232	35	8	6	9	4	1
Mean basal area/tree		3.9	10	17.5	1.7	451.6	19.9	7008.2
No. of trees/ 100m ²		193.3	29.2	6.7	5.0	7.5	3.3	.8
Mean basal area/ tree/100m ²		753.9	292.0	117.3	8.5	3387.0	65.8	5606.6

Dominance Ranks by Basal Area:

1. (7) Albizzia falcataria
2. (5) Cecropia obtusifolia
3. (1) Citharexylum caudatum
4. (2) Cordyline terminalis
5. (3) Brassaia actinophylla
6. (6) Erythrina sp.
7. (4) Macaranga grandifolia

Table 4. Frequency of each tree species by occurrence in 3 x 6m count-plots in a mixed forest community at the Lyon Arboretum, Mānoa Valley, O'ahu, Hawaiian Islands.

Count-Plot No.	Species						
	1	2	3	4	5	6	7
1	X	-	X	-	X	X	-
2	X	-	-	-	-	-	-
3	X	-	-	X	X	-	-
4	X	-	-	X	X	X	-
5	X	X	-	-	X	X	-
6	X	-	X	-	-	-	-
7	X	X	X	-	X	-	-
8	X	X	X	-	-	-	-
Total frequency	8/8	3/8	4/8	2/8	5/8	3/8	1/8
Percentage	100	37.5	50.0	2.50	62.5	37.5	12.5
Species 1 =	<u>Citharexylum caudatum</u>						
2 =	<u>Cordyline terminalis</u>						
3 =	<u>Brassaia actinophylla</u>						
4 =	<u>Macaranga grandifolia</u>						
5 =	<u>Cecropia obtusifolia</u>						
6 =	<u>Erythrina</u> sp.						
7 =	<u>Albizzia falcata</u>						

Table 5. Stand Structural Analysis of tree species from 6 x 20m Count-Plot Transect in a mixed forest community at the Lyon Arboretum, Mānoa Valley, O'ahu, Hawaiian Islands.

Diameter at base class (cm)	Range (cm)	Number of Trees in Species							Approx. Heights (meters)
		1	2	3	4	5	6	7	
1.5	(0-3)	220	19	3	6	0	2	0	<4.5
5.0	(4-6)	10	15	4	0	1	1	0	4.5 to
8.5	(7-10)	0	1	1	0	0	1	0	8
12.5	(11-14)	1	0	0	0	3	0	0	8 to
16.5	(15-18)	1	0	0	0	0	0	0	14
27.5	(25-30)	0	0	0	0	2	0	0	14 to
32.5	(30-35)	0	0	0	0	3	0	0	20
95.0	(95)	0	0	0	0	0	0	1	30
Total		232	35	8	6	9	4	1	295
Total over 3cm		12	16	5	0	9	2	1	44

Species 1 = Citharexylum caudatum 2 = Cordyline terminalis
 3 = Brassaia actinophylla 4 = Macaranga grandifolia
 5 = Cecropia obtusifolia 6 = Erythrina sp.
 7 = Albizzia falcata

STRUCTURE OF A DISTURBED FOREST COMMUNITY
REPLANTED WITH EUCALYPTUS ROBUSTA
ON WAI'ALAE NUI RIDGE, O'AHU, HAWAII

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INTRODUCTION

Already early in this century, much of the island of O'ahu had been deforested (Gerrish & Mueller-Dombois 1980). Large numbers of trees had been cut as fuel for steam-powered ships and industries. Some areas had been cut to supply the sandalwood trade. Grazing by farm and feral animals blocked forest regeneration. Development and urbanization used up much forest, or potentially forest, land. For many years the State of Hawaii Division of Forestry has had as a major objective the reforestation of these treeless areas. In some cases there were hopes for growing commercially valuable timber, but restoring watershed quality, combating soil erosion, and providing wildlife habitat were the major goals of reforestation.

Numerous species, both native and exotic, were considered and tested for reforestation use. While some recent studies suggest that some native tree species may hold their own against exotics, at least in some habitats (Wirawan 1974, Gerrish and Mueller-Dombois 1980), many earlier workers, including influential botanists such as Degener and Carlquist, believed that native species were unable to compete with introduced tree species. In light of this view, and the desire to alleviate the problems of deforestation as quickly as possible, exotic tree species were almost always chosen.

The choice of species was made on a site by site basis considering the specific needs and environmental constraints of the location. Often the choice was one of the Eucalyptus species. These trees are fast growing and hardy, and so were frequently chosen for watershed preservation and erosion control. Because the pathogens and insects which evolved with these trees in their native Australia had not been introduced with the trees, they grew here relatively disease and pest-free.

A stand of Eucalyptus robusta surrounds the Aina Koa 1370 Water Reservoir on Wai'alae Nui ridge. Construction on this reservoir was started in November 1968, and the final inspection on the completed project was carried out in March, 1971. Presumably the Eucalyptus as planted after this date, to reforest the disturbed area surrounding the construction site.

What has been the effect of this planting during the ensuing fifteen years? Are the Eucalyptus trees reproducing themselves? Are they spreading into neighboring areas? Has reproduction of native tree species been inhibited by the presence of this exotic species? If the original purpose of planting the Eucalyptus was to combat soil erosion, was this effective? Have the Eucalyptus been compatible with the development of vigorous shrub and herb layers, whose roots hold surface soil? Or have understory plants been inhibited by allelopathy? These questions were considered in a study of this stand carried out in March, April and May, 1986.

The stand is located immediately northeast of Aina Koa 1370 Reservoir, at the top of the subdivision designated "Wai'alaie Ridgeline Estates". This Bishop Estate land is on Wai'alaie Nui ridge, part of 'O'ahu's Ko'olau volcanic mountain range (Figure 1). Elevation is between 1320 to 1360 feet above sea level. Slope in the stand is moderate (approximately 20% in most areas). The aspect is south southeast on one side of the ridge, north northwest on the other.

Median annual rain fall at the site is approximately 890mm, with monthly medians varying from 45mm in September to 120mm in December (Taliaferro 1959). The winter of 1985-1986, however, was atypically dry, with rainfall far below normal. As of May sixth, rainfall at Honolulu International Airport was less than 20% of the normal amount for that date.

Temperature varies little from month to month, with the lowest monthly mean temperature in January of 20°C, while August and September are warmest with a mean of 24°C.

Soil at the study site is designated as Lāhainā silty clay. This soil type is found on the uplands of Lāna'i, Maui, Moloka'i, and 'O'ahu. It is a well drained soil, formed by the weathering of basic igneous rock. The surface layer is dark reddish brown, silty clay, approximately 38cm thick. The subsoil, approximately 115cm thick, is dusky red and dark reddish brown subangular blocky, silty clay and silty clay loam. The substratum is soft, weathered basic igneous rock (Foote, et al. 1972).

Ripperton and Hosaka (1942) classify this area as D1 on their vegetation map of the Hawaiian Islands. D1 is described as "shrub and closed forest" characterized by "guava, sensitive plant, Boston fern, Hilo grass, rice grass, basket grass, honohono, and staghorn fern." This classification may be suggestive, but it leaves out several important species on the site, and of course it does not anticipate the changes in floristic composition that have taken place since 1942.

Today the tree layer is dominated by Eucalyptus robusta



Figure 1. Contour map showing location of the study site on Wai'ala'e Nui Ridge, O'ahu, Hawai'i.

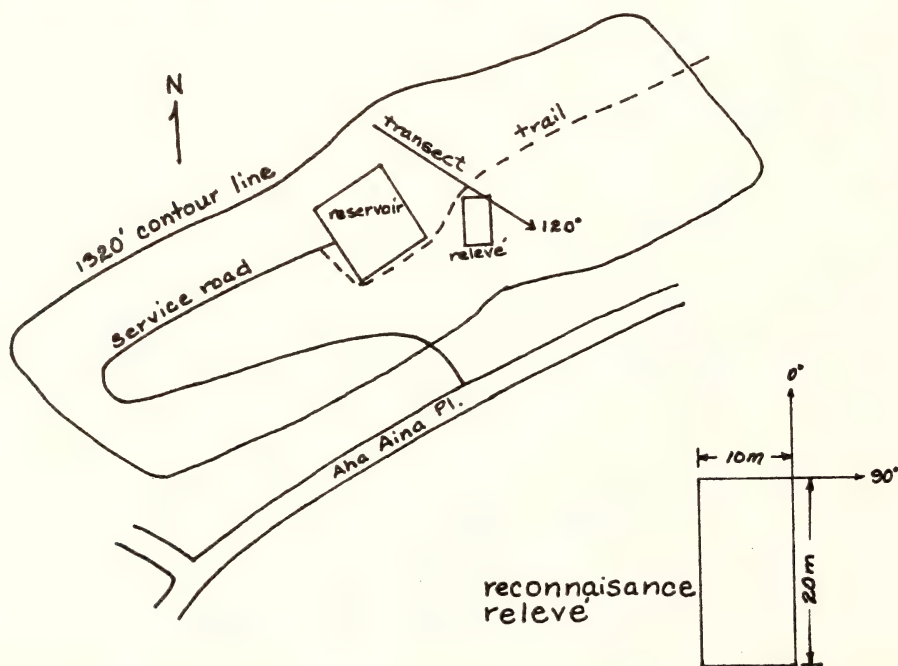


Figure 2. Transect and relevé layout at the study site on Wai'ala'e Nui Ridge, O'ahu, Hawai'i.

and Acacia koa. The shrub layer is dominated by Psidium cattleianum, Schinus terebinthifolius and Lantana camara. The herb layer is quite variable throughout the stand, with grasses (Paspalum sp. and Melinis minutiflora) dominant in the more open areas (Table 1).

Table 1. List of species by layers and cover value in a Eucalyptus robusta plantation on Wai'ala'e Nui Ridge, O'ahu, Hawaiian Islands.

Layer	Cover value	Species
T	3	<u>Eucalyptus robusta</u>
	2	<u>Acacia koa</u>
	+	<u>Schinus terebinthifolius</u>
S	1	<u>Psidium cattleianum</u>
	1	<u>S. terebinthifolius</u>
	r	<u>Psidium quajava</u>
	1	<u>Lantana camara</u>
H	+	fern sp.
	1	<u>Paspalum</u> sp.
	1	<u>Melinis minutiflora</u>
	+	<u>Desmondium incanum</u>
	1	<u>S. terebinthifolius</u>
	1	<u>L. camara</u>
	1	<u>Psidium cattleianum</u>
	r	<u>Psidium quajava</u>
	r	<u>Passiflora suberosa</u>
	+	<u>Cassia leschenaultiana</u>
	r	<u>Phyllanthus debilis</u>
	+	<u>Stachytarpheta jamaicensis</u>

METHODS

Preliminary reconnaissance included a 200m² relevé. This relevé was laid out as indicated in the study site diagram (Figure 2). Altitude was determined by altimeter, slope with an Abney level. Percent cover was estimated for a tree, shrub, herb, and litter layer. Abundance of each species was estimated and recorded according to the Braun-Blanquet scale.

Size-class distribution of tree species in the community was sampled by the count-plot, or "quadrat method" as outlined by Mueller-Dombois and Ellenberg (1974). A belt transect, 60m long, was laid out in an area seemingly representative of variation within the community. Sub-plots, 3 X 5m, were laid out, continuously along the transect (Figure 2). All

individual trees were recorded with basal diameter and stem length with a three meter gauge. Holding this gauge at two meters above the ground permitted measurement up to five meters. Stem lengths greater than five meters were estimated by one worker standing back and comparing the stem length to the gauge held to five meters by another worker.

Total area of sub-plots was 360m^2 , approximately five percent of the estimated area of the community. Six tree species were recorded, with a total of 152 individuals.

In a timber survey, a sample of five percent of the total area of a stand would often be considered adequate. For this type of a study, however, the number of individuals recorded is probably more important than sample area. If we consider all tree species together, and assume a random distribution, we can use as an error term the ratio of the standard error of the mean to the mean (Mueller-Dombois and Ellenberg 1974). For 152 individuals, this error term equals 0.08, suggesting that our data is highly significant. For individual species, however, the number of distribution cannot be made. Therefore the structural analysis of individual species must be seen as preliminary. A larger sample size would be required to describe these populations with confidence.

The study site was located on a U.S.D.A. soil survey map (Foote, et al. 1972). Shallow excavation, and inspection of the soil profile revealed by construction excavation surrounding the water reservoir confirmed the description in the soil survey.

Efforts were made to obtain records of the planting of this stand from the Honolulu Board of Water Supply, Hawaii State Division of Forestry and Bishop Estate land department. None of these had records relating to this stand, beyond the construction dates for the water reservoir. Lacking such historical records, analysis of population dynamics in the stand were done solely on the basis of the population structure of the tree species currently present on the stand.

RESULTS

Many of the Acacia koa in this stand showed a very gnarled "orchard stature" growth habit. Stem length was difficult to estimate accurately for these trees, and there was a very poor correlation between basal diameter and stem length. For this reason basal diameter was used as the measure of tree size in plotting the structure of these populations.

For Eucalyptus robusta, trees were divided into size classes of six cm. increments in basal diameter. The relative abundance of each size class could be fitted to a smooth curve (Figure 3). Grouping all trees up to 6cm basal diameter does

not specifically describe the population of seedlings--in this case there were none found.

Acacia koa were placed into the same size classes, and plotted against relative abundance (Figure 4). Again there were no seedlings found.

The largest Eucalyptus on each sub-plot was plotted against the position of that sub-plot along the transect (Figure 5). The solid line represents a visual line of best fit joining the largest trees along the transect, ignoring sub-plots with none or smaller trees interspersed among larger trees. If size of these trees is proportional to age, the curve represents an age profile of this population along the transect. The density of A. koa by sub-plot is plotted on this same graph. The trend of the data points (x) is represented by the dot-dash line of visual best fit. Plotting these on the same graph allows consideration of possible interaction between the two species.

DISCUSSION

Determining the population structure of a tropical forest is a challenging project. Because there is no regular harsh season, there are no growth rings with which to determine tree age. In this case no historical records were found to pinpoint planting dates, etc. Nevertheless, many aspects of population dynamics in a stand can be learned from an analysis of the trees present on the stand today (Mueller-Dombois and Ellenberg 1974).

The typical structure for a population that is healthy and reproducing itself consists of large numbers of young trees, with sharply fewer mature trees, whose numbers gradually decline as senescence approaches. Many factors affect tree size, and there is no uniform correlation between age and size. Over a reasonably small, uniform area, for a given species, however, that bigger trees are older seems to be a reasonable working assumption. Using this assumption, and looking at the size vs. abundance graph for Eucalyptus (Figure 3) makes it clear that the species is reproducing itself, and seems to be naturalized on the site. How can this be reconciled with the absence of seedlings? Three possibilities suggest themselves: the very dry winter prevented germination of seeds; seedling germination is seasonal; or, none are naturally present at the time of this field work.

If these reforestation trees have successfully established themselves on this site, are they going beyond this? Are they spreading into neighboring areas? Again, this is difficult to determine without historical records, as the original boundaries of the planting are not known. Looking at the largest size profile (Figure 5) suggests that they are. A stand resulting from a single planting which did not spread at

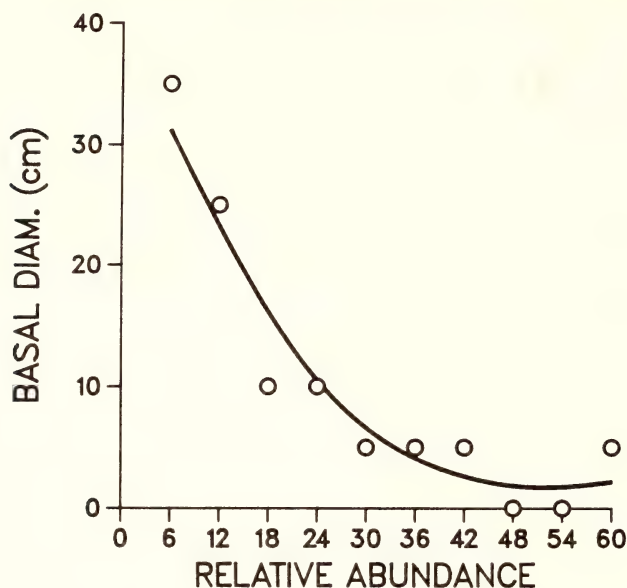


Figure 3. Size class distribution of *Eucalyptus robusta* on Wai'alae Nui Ridge, O'ahu, Hawai'i.

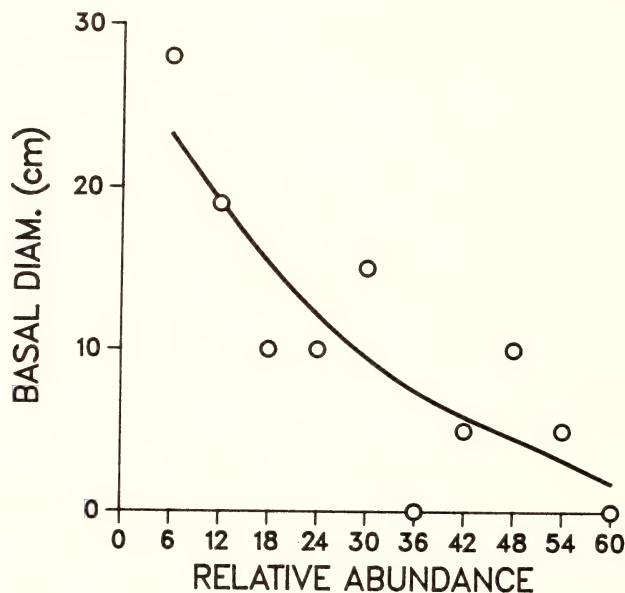


Figure 4. Size class distribution of *Acacia koa* on Wai'alae Nui Ridge, O'ahu, Hawai'i.

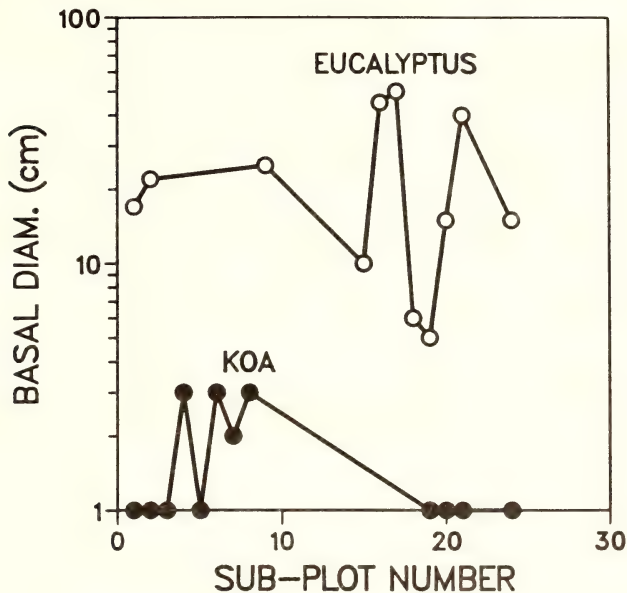


Figure 5. Largest Eucalyptus plotted against Acacia koa density in each subplot of study area, Wai'ala'e Nui Ridge, O'ahu, Hawai'i.

all would be expected to have a very uniform profile of largest trees, dropping off suddenly at the boundaries of the original planting. What is seen for E. robusta on this stand is a gradual decline in largest trees over some twenty meters along the transect. This suggests a gradual spreading process, as offspring from the original planting are located over a slightly larger area, their offspring over a slightly larger area yet, and so on.

It is possible that essential oils produced by some Eucalyptus species (Ting 1982) act to inhibit germination of seeds of other species. If this allelopathic effect were sufficiently powerful, it could result in bare soil beneath Eucalyptus sp. stands, and thus render the trees considerably less effective in erosion control, as surface soil, not anchored by deep tree roots would still be vulnerable. These possible allelopathic effects are not evident in this stand. Though not uniform, most of the stand has a vigorous understory of shrubs or herbs. The reconnaissance relevé was estimated to have 60% herb cover and 10% shrub cover.

If the E. robusta are not causing a generalized inhibition of herbs and shrubs, are they possibly inhibiting the normal regeneration of native trees on the site? Looking at the size distribution of Acacia koa, the dominant native Hawaiian tree in the stand, (Figure 4), it can be seen that the population is healthy, with a high proportion of small (young) trees. Again no seedlings were found, but the same factors explaining lack of E. robusta seedlings may apply here. Despite this healthy, reproducing population structure for A. koa, there is some evidence that this species may be somehow inhibited by the presence of E. robusta at this site. Those sub-plots along the transect which have the largest E. robusta individuals, and therefore have presumably had E. robusta present for the longest time, tend to have the lowest density of A. koa. While this inverse correlation may indicate some sort of inhibition of A. koa by E. robusta, this relationship is by no means proven, and there are many alternative explanations for this data.

As discussed under "Methods" above, all of the patterns suggested in this study must be viewed critically. The sample size for any individual species simply was not large enough to provide a high level of statistical confidence. Still, if one was to hazard some tentative conclusion, it does appear that planting E. robusta on this disturbed site was effective in rapidly regenerating forest cover. These trees have grown rapidly, they are reproducing themselves, and they seem to be compatible with a vigorous understory growth. As a whole this community would seem to be effective at controlling soil erosion.

There are some areas for concern. There is evidence that Eucalyptus is spreading beyond the area of the original planting. Furthermore, while the A. koa population on the site appears to be healthy, there is the possibility of some level of inhibition, or perhaps competitive disadvantage, for these native trees. These questions should be studied further for any thorough evaluation of the use of E. robusta in reforestation.

ACKNOWLEDGMENTS

Mr. Kikukawa, of Forestry, was very helpful to me in attempting to find historical information about my study site. He also kindly shared with me some of his knowledge of the history of forestry in Hawaii, including things he had learned from the "real old timers".

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The amendment to the Constitution of the Hawaiian Botanical Society was a rare event, but William Bush, one of the two members who proposed the amendment felt that it was time to change the wording of the Constitution that did not allow a person to serve as President for more than one (1) year. He remembered back "in the old days" when Section IV of Article 4 regarding officers was put into the Constitution. It was political, he said, and was done to keep certain people out of office interminably(!). Nowadays, we have trouble persuading people to run the Society!

NOTE FROM THE EDITOR

We have enough articles to maintain publication of the Newsletter at four volumes, each containing an average of forty pages, per year. Most of these articles are reports from various surveys conducted over the last five years.

However, I would like to receive more publications from members. We are particularly interested in notes on new occurrences of natives and aliens on all islands. This includes range expansions. Also, if someone has a pet weed that they think needs a closer watch, an article on its distribution and estimates of its potential weediness would be very appropriate.

Please make every effort to make the Newsletter a useful instrument for disseminating ideas and concerns. That is its function and that is what we need. Thankyou.

RESULTS OF QUESTIONNAIRE SENT TO MEMBERSHIP IN 1985

A year ago, President Lewis asked members to propose activities for the Society, and to express their interests. The results of the questionnaire are summarized, as percentages, below. There were 49 responses, but not everyone expressed an opinion on everything.

	Scale:- 1 2 3 4 5				
	PERCENTAGES				
	Always 20	14	35	20	Never 11
	Strongly agree			Strongly disagree	
1. Attend meetings?					
The Hawaiian Botanical Society should:					
2. consider holding meetings at Bishop Museum.	14	16	19	8	43
3. meet year-round.	31	17	32	3	17
4. minimize business handled at general meetings.	24	16	30	11	19
5. play an active and responsible role in Hawai'i botanically and environmentally.	75	13	4	6	2
6. support and encourage pure research on the native flora of Hawai'i.	88	6	6	0	0
pure research on the "alien" flora of Hawai'i.	47	24	20	7	2
pure research on plants outside of Hawai'i.	5	7	21	30	37
applied research on native flora of Hawai'i.	70	13	15	0	2
applied research on "alien" flora of Hawai'i.	44	17	27	10	2
applied research on plants outside of Hawai'i.	4	9	22	22	43
conservation efforts in Hawai'i	73	17	8	2	0
conservation efforts outside Hawai'i	11	11	39	25	14
public education.	68	24	6	2	0
botanical publications.	41	30	23	4	2
propagation & dissemination of native plants.	49	27	13	9	2
7. consider providing financial support for small research/conservation/other projects based on written applications judged competitively by a committee.	46	29	12	8	4
8. improve the <u>Newsletter's</u> consistency in dates and times.	65	20	13	2	0
format.	24	12	43	14	7
9. collaborate with other societies (i.e. horticultural, hiking, conservation).	37	32	23	4	2
10. be involved in "service" projects.	34	23	30	11	2
11. be an active voice in conservation legislation.	53	31	8	4	4
12. organize more group activities for membership.	34	21	33	7	12

Considering only the members who live on O'ahu, 11 out of 38 gave a reason for not attending more often. Two at scale 5 (never) lived outside Honolulu, and five others, scale 3 or 4, found the time or location inconvenient or too distant. Two others had conflicts, but only two (at scale 3, 4) cited any lack of topic interest. One mentioned the University parking fee for on-campus meetings.

Suggestions for other Society activities ranged from "encourage lay persons" to "service projects, as on Coconut Island or Makiki Heights" or "public school lectures", and "plan more field trips, courtyard cookouts, workshops".

If one considers 75% or 80% of the membership in accord -- say, the sum of percentages at scale 1+2 or at 4+5 -- there were several areas in which the general membership agreed well, as to the role of the Society. For example, 88% agreed or strongly agreed that the Society should be active in botanical and environmental arenas in Hawai'i. Some 94% would support and encourage "pure" research on the native flora, 83% were in favor of "applied" research on the native flora. Although 90% supported conservation efforts in Hawai'i, fewer (76%) favored active propagation and distribution of native plants. Some 92% favored efforts in public education, but only 71% favored botanical publications by the Society.

Interest was less in supporting any pure or applied research on the "alien" flora, and 67% were disinclined to support such activities as to plants outside of Hawai'i. Of course, those whose answers were at scale 3 (neutral) on this questionnaire might well take a stronger stand when some specific action were to be proposed. And further, though 84% were in favor of involvement with conservation legislation, some were quite opposed. (There are only a few zero percentages on the chart.)

The questionnaire also asked who would be willing to help in some of the present activities, say with the Newsletter, on the Conservation Committee, or Native Plants Committee, or on some committee for project grants. There were some 29 names on the lists in these four areas, representing 15 different individuals. There were also suggestions given for hands-on service trips with the Sierra Club, Audubon Society, or the Conservation Council, etc., and for at least one meeting in the year on Hawai'i, for example.

Of the 52 members who indicated the primary area of their botanical interest, 26% listed some aspect of the native flora, 11% conservation, and lesser percentages for horticulture, ecology, and specific botanical sciences. Surely, however, lack of a specific listing did not signify a lack of interest, and about 12% of this sample cited a general interest.

We wish to thank members who responded so fully, and will welcome further comments at any time.

REQUEST FOR OBSERVATIONS ON RUBUS

Lani Stemmermann
P.O. Box 308
Volcano, HI 96785

I am presently working with the Cooperative Parks Resources Study Unit/UH (CPSU) to map the distribution of all Rubus species (blackberry, raspberry, akala, thimbleberry) throughout the state. The National Park Service in cooperation with the US Forest Service and State Department of Land and Natural Resources is now investigating the possibility of introducing further biological control (frequently now abbreviated to biocontrol) agents to control noxious Rubus species. Any candidate biocontrol agents will undergo extensive testing prior to release to ensure that they do not affect any economically important species, the native akala, or other native species. Before any such program is implemented, it is necessary to determine the respective distributions of all the species.

In 1983 I collected a specimen of Rubus along Lanipō trail (Mau'umae ridge), O'ahu, at approximately 1,350 ft elevation in an old burned area. That specimen has been subsequently tentatively identified as R. discolor by D. E. Boufford (for the Bishop Museum Hawaiian Flora Manual project) following comparison of that specimen with the L. H. Bailey Rubus collection at Harvard. A collection of this taxon has also been made from Kaulalewelewe, W. Maui (Krauss 1136). It resembles the local weedy blackberry somewhat, differing from it in being a smaller statured shrub with smaller leaves that are white on the lower surface.

I recently returned to the O'ahu collection site to examine the extent of this species' distribution. It is occurs in rather extensive patches throughout a several acre area that was previously burned. It is densest in a swale E. of the ridge proper between the trail and a Casuarina grove, and along a slope just E. of the trail among dense Scaevola. The burned site is dominated by Scaevola gaudichaudiana, Acacia koa, Psidium cattleianum and Santalum freycinetianum, all to 2⁺m, with patches of Andropogon virginicus and Setaria geniculata.

Alien Rubus species have spread extensively on establishment in Hawai'i. The patch along Lanipō trail appears to be limited to the burn area, and may be small enough to control. It spreads locally by underground runners, making pulling of the existing plants an ineffective means of control. It is also setting fruit, but plants have not been found established beyond this burn area. Adjacent ridges are now being surveyed for the presence of this species. Even if the plant is currently confined to this locality, there is the distinct possibility that it will be spread very rapidly by the many alien frugivorous birds.

It would be helpful if additional sitings of this species in the Ko'olau Range, or elsewhere could be reported to myself (P. O. Box 308 Volcano, Hawaii 96785 (Big Island ph. 967-7631)) or by leaving a message with Cliff Smith (O'ahu 948-8218). Any distributions of other Rubus taxa which seem unusual, or which are not generally known are also of considerable interest. Does anyone know of any blackberry any where in the Ko'olau range? Assistance on this project may contribute to the success of removal of some of these pests, and would be much appreciated.

This project will also cover all of the other islands. I would appreciate it if people would keep mental notes of where they see or do not see any Rubus species for later reference. Thank you. Lani Stemmermann.

If you feel that the proposed H-3 highway "goes nowhere" (it actually will come out near Moanalua, and would be great if you lived in Kāne'ohe and worked in Pearl Harbor or Schofield Barracks, which less than 15% of the commuters from the windward side do), and if you think that it is important to protect Ho'omaluhia Park, you might alert your friends and relatives who live in Vermont, Idaho, Rhode Island, South Dakota, North Dakota, Maine and Texas to write to Senators Stafford, Symms, Chafee, Abenor, Burdick, Mitchell, Benson, repectively to vote against the Hawai'i proposal to exempt federal requirements applying to the construction of H-3 (with Federal funds). The money would more appropriately be spent on other highway needs on this island (that would affect many more people than the few who would be using H-3). Furthermore, the Luluku archaeological site that was unearthed is one of the oldest taro terraces in the Hawaiian Islands and indicates that the spread from the oldest known landing (near Bellows Field, O'ahu) was quite early--earlier than there had been evidence for previously. H-3 would probably demolish this site before there is time to study it properly.

THE DEMISE OF A SPECIES: URERA KAALAE

John K. Obata
Botany Department
Bishop Museum

Urera kaalae Wawra was collected by Chamisso in 1816 or 1817 and lay unidentified in a Russian Museum (Degener 1936) until Wawra gave it an identity in 1874 with its rediscovery and description. It is a species of sloping, open terrain with little or no cover or open gully understories. With the development of the forest cover in recent years, this species has been relegated to talus slopes at the 640 meter (2100 ft) level within the Kunia mountains in the southern Wai'anae Range of O'ahu. As late as 1960, it was even observed by this writer along the Honouliuli Contour trail, below Pu'u Hāpapa. This was its lowest limit in recent times while its uppermost limit was at the head of Huliwai Gulch, off Pu'u Kānehōa. The taxa was fairly common then.

Recently an attempt was made to photograph the last remaining population of three small trees. No trace of the remnant population could be found even though they were observed about three years previously. A frantic search yielded about fifty seedlings and saplings. In a subsequent trip over sixty young plants were counted. One young adult, probably a remnant of a previous germination, was observed in bloom for the first time.

This colony was lush and healthy fifteen years ago. It has been relegated to extinction but has since regenerated. One wonders whether this is a natural cyclic phenomenon. This process seems peculiar to some other species. Perhaps many others subscribe to this pattern.

If this analogy is correct, extinction of many of Hawaiian flowering plants have reached a crisis stage. Many taxa find their habitat along open recesses and thrive among them. Germination, growth, reproduction and eventual demise of a taxon is orchestrated apparently in this short and repeating cycle--if conditions are left at an optimum. What if heavy overstory and aggressive competition arise in a territorial claim? The aggressive taxon will survive. Small endemic trees and shrubs can survive only if adaptation is made to a changing habitat or their offspring can coexist with the competing taxa. Urera kaalae illustrated this phenomenon in recent years as they were found only at the 640 meter (2100 ft.) level and only along talus rocky slopes which other taxa generally shunned. Even this habitat presently is severely threatened by Passiflora suberosa with Christmas Berry (Schinus terebinthifolius) and wai'awi (Psidium cattleianum) inching in rapidly. Can we save this taxon or many others in like predicaments?

The prognosis for this taxon is simple. Without control of these aggressive aliens, this group of seedlings should be the last survivors of the taxon. Perhaps about ten saplings will reach maturity and try to continue its cycle. Or will it succumb to the grim reality of extinction? Is there a mechanism of assistance not only for Urera kaalae but to all other endemic Hawaiian species in similar circumstances? At the present rate of development of our aggressive alien forest weeds, the end seems to be in sight for many of the endemic Hawaiian flora by the year 2000. Massive and radical biological and physical control measures must be instituted to save our native forest. It is worth a gamble.

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Please note that the mailing label on this issue of the Newsletter shows the year of your last dues payment and membership status. If this information is in error, please advise the Treasurer, Dr. Derral Herbst, 531 Hahaione St., #220-A, Honolulu, HI 96822, or c/o Botany Dept., Bishop Museum, P.O. Box 19000-A, Honolulu, HI 96817-0916.

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HAWAIIAN BOTANICAL SOCIETY
C/O DEPARTMENT OF BOTANY
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SYMPOSIUM ON CONTROL OF INTRODUCED PLANTS
IN NATIVE ECOSYSTEMS OF HAWAII:
SUMMARY OF PRESENTATIONS

Z. E. Ellshoff
Honolulu Botanic Gardens
50 N. Vineyard Blvd.
HONOLULU HI 96817

Attending the Symposium on Control of Introduced Plants in Native Ecosystems of Hawaii left some overall impressions of the problem of introduced plants in Hawaii and what is being done about the problem. Many plants not naturally growing in Hawaii have been brought here for a variety of reasons--as vegetable or ornamental plants, as forage plants, as crop plants, for reforestation, or accidentally. Many of these plants have become naturalized and can grow on their own and reproduce in the natural environment. Some have become pests which grow prolifically, taking the growing space of native Hawaiian plants and even previously introduced alien plants. In some areas, such as the National Parks and nature preserves, attempts are being made to control these problem plants so that a more natural landscape can be retained or regained.

Following is a summary of the important facts gleaned from papers presented. Reference is made to the presentations by listing presentation number followed by the first author's name: "1. Loope" refers to presentation number given by L. L. Loope. Presentation numbers refer to the symposium program (attached).

When the first Polynesians arrived in the Hawaiian Islands, about 2700 species and infraspecific taxa were growing naturally here. These colonizers brought with them 32 species (Nagata 1985) of plants which were used for food, medicine, and to make articles of daily living. Major changes in the lowland vegetation were initiated by Hawaiians because of clearing for farming and living areas. An indeterminable number of species of endemic lowland forest plants probably became extinct as a result of these changes.

More than a thousand years after the Polynesians settled in Hawaii (Newman 1972), Western man discovered Hawaii, and Europeans began to settle here. Many more plants were introduced to Hawaii for a variety of reasons. Many were brought as food plants and ornamentals; the settlers were familiar with these plants in their homeland, so they brought them to Hawaii. Some plants were agricultural introductions, such as crop plants or forage plants for grazing animals. Some inadvertent introductions were made as weed seeds in imported seed. (34. Cran)

Grazing animals had destroyed much forest area by the early 1900's, and many new species were introduced for

reforestation. Harold L. Lyon of the Hawaii Sugar Planters' Association felt that native Hawaiian trees were doomed, and he encouraged a policy of planting a mixture of introduced trees, shrubs, and vines to protect the watershed. (33. Weimer)

Hawai'i has a thriving ornamental plant industry. Cut flowers, used by lei makers and florists, are chosen not so much for type of plant but for practical considerations such as quality, quantity available, time of availability, and cost. Foliage plants, used by decorators and landscape architects, are chosen mostly for their ability to survive well in a given environment. Nurseries specializing in ornamental nonfoliage plants depend on new and unusual kinds of plants. These are obtained by serendipitous discovery of a mutant type, hybridization, and importation of wild-collected plants. (32. Yee) The marginal profit made by many of these small nurseries encourages breaking of import rules. (31. Higa) A fortune can be made if a popular introduction is found, but most new plants do not prove to be so successful.

Workers at Bishop Museum revising Marie C. Neal's book In Gardens of Hawaii have found that most new plants are brought into the state by arboreta and botanical gardens. From arboreta and botanical garden checklists, herbarium specimens in Bishop Museum, and listings in Neal's book, a checklist of about 8000 names of plants growing in Hawaii was made and divided into frequently, occasionally, or rarely cultivated, and specimen (one-of-a-kind) plants. Workers on the Flora project at Bishop Museum have found that about 800 (10%) of these introduced plants have become naturalized. (6. Wester, 32. Yee)

Many naturalized plants pose no serious threat to the existing native vegetation of the Hawaiian Islands. They grow in lowland areas that have already been changed drastically from their original state by man for habitation, farming, or grazing. Alien plants invading at higher elevations, however, can pose a threat to more intact native ecosystems. Disturbances produced by pigs, goats, and sheep open areas for invasion. These mammals and introduced fruit-eating birds can bring seeds of the alien plants into the areas. Introduced plants which grow well in areas like these can thrive, outcompete native species so they do not reproduce, and change the make-up of the native forests. (F. Jacobi, B. Anderson)

Some alien plants are so aggressive that the National Parks Service has begun eradicating them in the Parks and monitoring the cleared areas (7. Jacobi, 14. Santos, 15. Tunison, 17. Davis, 20. Markin, 21. Tunison, 37. Taylor, 39. Tunison). In Hawai'i Volcanoes National Park, 37 highly localized species (Table 1) and another eight widespread species (Table 2) have been targeted for immediate control. Biological control possibilities of five species are being evaluated, and another five other species are future

Table 1. Highly localized species designated as target species for control, Hawai'i Volcanoes National Park. (Hawaii Volcanoes National Park Natural Resources Management Plan, 1986 update).

Scientific name	Plant family	Common name
<u>Acacia confusa</u>	Mimosaceae	Formosan koa
<u>Acacia decurrens</u>	Mimosaceae	black wattle
<u>Acacia melanoxylon</u>	Mimosaceae	blackwood acacia
<u>Agave americana</u>	Agavaceae	century plant
<u>Agave sisalana</u>	Agavaceae	sisal
<u>Albizia</u> sp.	Mimosaceae	albizzia
<u>Arthrostemma latifolia</u>	Melastomataceae	arthrostemma
<u>Benincasa hispida</u>	Cucurbitaceae	Chinese melon
<u>Casuarina equisetifolia</u>	Casuarinaceae	ironwood
<u>Eleagnus</u> sp.	Eleagnaceae	eleagnus
<u>Eriobotrya japonica</u>	Rosaceae	loquat
<u>Eucalyptus</u> sp.	Myrtaceae	eucalyptus
<u>Eugenia jambos</u>	Myrtaceae	rose apple
<u>Feijoya sellowiana</u>	Myrtaceae	guavasteen
<u>Ficus pumila</u>	Moraceae	climbing fig
<u>Fraxinus americana</u>	Oleaceae	white ash
<u>Fraxinus uhdei</u>	Oleaceae	tropical ash
<u>Fuchsia arborescens</u>	Onagraceae	fuchsia
<u>Hedera helix</u>	Araliaceae	Englign ivy
<u>Heterocentron subtriplinervium</u>	Melastomataceae	pearl flower
<u>Luculia gratissima</u>	Rubiaceae	luculia
<u>Lupinus</u> sp.	Fabaceae	lupine
<u>Melaleuca leucadendra</u>	Myrtaceae	paper bark
<u>Melochia umbellata</u>	Sterculiaceae	melochia
<u>Muhlenbeckia axillaris</u>	Polygonaceae	wire plant
<u>Opuntia megacantha</u>	Cactaceae	prickly pear
<u>Paederia foetida</u>	Rubiaceae	Maile pilau,
<u>Phoenix dactylifera</u>	Arecaceae	date palm
<u>Phormium tenax</u>	Liliaceae	New Zealand flax
<u>Phyllostachys</u> sp.	Poaceae	bamboo
<u>Pinus</u> sp.	Pinaceae	pine
<u>Pittosporum undulatum</u>	Pittosporaceae	pittosporum
<u>Prosopis pallida</u>	Mimosaceae	kiawe
<u>Pueraria lobata</u>	Fabaceae	kudzu
<u>Ricinus communis</u>	Euphorbiaceae	castor bean
<u>Tibouchina urvilleana</u>	Melastomataceae	glory-bush
<u>Trema orientalis</u>	Ulmaceae	gunpowder tree

Table 2. Widespread species targeted for control on a priority order basis, Hawai'i Volcanoes National Park. (Hawaii Volcanoes National Park Natural Resources Management Plan, 1986 update).

Priority number	Scientific name	Plant family	Common name
1.	<i>Pennisetum setaceum</i>	Poaceae	fountain grass
2.	<i>Hedychium gardnerianum</i>	Zingiberaceae	kahili ginger
3.	<i>Pennisetum clandestinum</i>	Poaceae	kikuyu grass
4.	<i>Leucaena leucocephala</i>	Mimosaceae	koa-haole
5.	<i>Rubus glaucus</i>	Rosaceae	raspberry
6.	<i>Linociera ligustrina</i>	Oleaceae	linociera
7.	<i>Grevillea robusta</i>	Proteaceae	silk oak
8.	<i>Schinus terebinthifolius</i>	Anacardiaceae	Christmas berry

possibilities (Table 3). Other national parks have problems with aggressive introduced plants, and workers from Everglades National Park (4. LaRosa) and Channel Islands National Park (5. Halvorson) spoke on their problems, research, and measures being taken. Attempts are being made to eradicate other species by researchers and workers in Haleakalā National Park (13. Anderson, 24. Loope), on Nature Conservancy preserves (22. Holt, 41. Misaki), in State Natural Area Reserves (23. Tanimoto), and by researchers with other affiliations (9. Whiteaker, 10. Smith, 18. Gardner, 19. Nakahara, 25. Tulang). (Table 4)

Programs for removal of feral mammals have been successful in stemming alien invasion of native areas (29. Scowcroft, 30. Stone). Use of fire as a management tool has been tried but is apparently not useful in the native forests because native species are slow to recover and aliens take the fire disturbance as an invitation to invade. (16. Smith)

Several papers addressed the theoretical ideas of what a weed is, how an invasive plant can be identified, and how to decide which plants to try to control. A weed is often defined as one which thrives in a disturbed area. When the disturbance no longer exists, the weed will be replaced by other species. But island ecosystems show more permanent changes after disturbance. (1. Loope, 28. Merlin) Disturbance does not have to be caused by human beings. The invasion of vines, and aquatic vascular plants can occur with no previous disturbance. (3. Mack) Natural vegetation in an area is part of the balanced ecosystem of that area. A plant introduced into an area may thrive but at the expense of the balance of other organisms and resources. (2. Vitousek) Characteristics of successful invaders are diverse and include dispersal ease and tolerance of range beyond initial introduction site. If

Table 3. Species with biological control possibilities, Hawai'i Volcanoes National Park. (Hawaii Volcanoes National Park Natural Resources Management Plan, 1986 update).

Scientific name	Plant family	Common name
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Species currently being investigated:

<u>Myrica faya</u>	Myricaceae	firetree
<u>Passiflora mollissima</u>	Passifloraceae	banana poka
<u>Rubus ellipticus</u>	Rosaceae	yellow raspberry
<u>Rubus glaucus</u>	Rosaceae	raspberry
<u>Rubus penetrans</u>	Rosaceae	blackberry

Future candidates:

<u>Andropogon glomeratus</u>	Poaceae	bush beardgrass
<u>Andropogon virginicus</u>	Poaceae	broomsedge
<u>Melinis minutiflora</u>	Poaceae	molasses grass
<u>Pennisetum setaceum</u>	Poaceae	fountain grass
<u>Psidium cattleianum</u>	Myrtaceae	strawberry guava

Table 4. Other species for which eradication programs exist. (9. Whiteaker, 10. Smith, 18. Gardner, 19. Nakahara, & 25. Tulang).

Scientific name	Plant family	Common name
<u>Ageratina riparia</u>	Asteraceae	Hamakua pamakani ageratina
<u>Ulex eropaeus</u>	Fabaceae	gorse
<u>Clidemia hirta</u>	Melastomataceae	Koster's curse
<u>Lanatania camara</u>	Verbenaceae	lantana

natural pathogens and predators of the plant are not present in the new site, the invader is at an advantage. (3. Mack)

By studying the history of long-standing weeds (retrospective epidemiology), insights can be gained into patterns of invasion which may help in control of other weeds. A study of Bromus tectorum in the Pacific northwest showed the mathematical and biological advantages of removing satellite populations first and working in from the border when attacking a large infestation. (35. Mack) Similar historical studies in Hawai'i include those on Clidemia hirta (10. Smith), Verbascum thapsus (11. Juvik) and Passiflora mollissima (12. LaRosa).

The use of the "artificial intelligence" or rule-based decision-making capabilities of computers can help make inferences about which introduced plants may become problems and where. A logic-based program can answer questions based on data available from herbarium specimens, field notes, and literature observations. (36. Bridges)

Public education and involvement in the alien plant problem is also important. Once people are aware of the uniqueness of the flora of the Hawaiian Islands, that introduced plants pose a threat to the flora, and that some native plants have good ornamental possibilities, the market for exotic plants can change (32. Yee) Environmental education beginning in grade school and reinforced in intermediate and high schools is important, and class trips to nature centers are popular with school teachers. (40. Hawkins) Natural areas such Kamakou Preserve on Moloka'i have programs of community involvement in which volunteers come to vacation, learn about the natural environment, and pull weeds. (41. Misaki)

A short afternoon field trip considered some of the management, technical and political problems that the National Park Service faces in controlling alien species. Participants were also shown the new insect quarantine facility in which potential biological control agents are screened before being considered for release.

LITERATURE CITED

- Nagata, K. M. 1985. Early plant introductions in Hawai'i. Hawaiian J. of History. 19:35-61.
- Newman, T. S. 1972. Man in the prehistoric Hawaiian ecosystem. In Kay, E. A. (ed.). 1972. A natural history of the Hawaiian Islands: Selected readings. Univ. of Hawaii Press, Honolulu. Pp. 559-603.

PROGRAM

SYMPOSIUM ON CONTROL OF INTRODUCED PLANTS
IN NATIVE ECOSYSTEMS OF HAWAII

June 10-12, 1986

OPENING REMARKS. D.B. Ames, B.M. Kilgore, C.P. Stone

I. PERSPECTIVES (C.P. Stone, Chairman)

1. An overview of problems with introduced plant species in national parks and reserves of the United States. L.L. Loope
2. Effects of alien plants on native ecosystems. P.M. Vitousek
3. Characteristics of invading plant species. R.N. Mack
4. Alien plant management in Everglades National Park: an historical perspective. A.M. LaRosa
5. Alien plants at Channel Islands National Park. W.L. Halvorson

II. STATUS AND DISTRIBUTION OF
SOME IMPORTANT ALIEN PLANTS IN HAWAII
(R. Hobdy, Chairman)

6. Alien plants and their status in Hawaii. L.L. Wester
7. Distribution and abundance of selected alien plants in native upland habitats on the island of Hawaii. J.D. Jacobi
8. Alien plants on the Northwestern Hawaiian Islands. D.R. Herbst and W.L. Wagner
9. The distribution of Myrica faya in the state of Hawaii. L.D. Whiteaker and D.E. Gardner
10. Distribution, status, phenology, rate of spread, and management of Clidemia hirta in Hawaii. C.W. Smith
11. Verbascum thapsus: the spread and adaptation of a temperate weed in the montane tropics. J.O. Juvik and S.J. Juvik
12. The status, phenology, distribution and rate of spread of Passiflora mollissima in Hawaii. A.M. LaRosa
13. Distribution and spread of alien plants in Kipahulu Valley, Haleakalā National Park, above 3,000 feet. S.J. Anderson, C.P. Stone, and P.K. Higashino

III. PHYSICAL AND CHEMICAL CONTROL (D.D. Taylor, Chairman)

14. Chemical control of selected alien plant species in Hawai'i Volcanoes National Park. G.L. Santos and D.E. Gardner
15. Pennisetum sectaceum control in Hawai'i Volcanoes National Park: effort, economics, and feasibility. J.T. Tunison
16. Fire and alien plants in Hawai'i: problems and control feasibility. C.W. Smith and J.T. Tunison

IV. BIOLOGICAL CONTROL (J.W. Beardsley, Chairman)

17. Biocontrol of Lantana camara, Opuntia spp., and Ageratina riparia in Hawai'i. C.J. Davis, E. Yosioka, and A.V.D. Kageler
18. Plant pathogens as biocontrol agents in native Hawaiian ecosystems. D.E. Gardner
19. Review and status of insects for biological control of Clidemia hirta in Hawai'i. L.M. Nakahara, R.M. Burkhart, and G.Y. Funasaki
20. Present status and future of biological control of weeds in Hawai'i, and implications for management of native ecosystems. G.P. Markin

V. AGENCY, ORGANIZATION, AND LANDOWNER APPROACHES
(C.E. Conrad, Chairman)

21. Success in controlling localized exotic plants in Hawai'i Volcanoes National Park. J.T. Tunison and N.G. Zimmer
22. Control of alien plants on The Nature Conservancy preserves. R.A. Holt
23. Alien plant control on State lands including Natural Area Reserves. V. Tanimoto and W.P. Char
24. Introduced plants in Haleakalā National Park. L.L. Loope, R.G. Nagata, and A.C. Medeiros
25. The U.S. Department of Agriculture's rural development approach to alien plant control in Hawai'i. M. Tulang
26. Exotic plant control on private lands. C. Bredhoff
27. Constraints, restraints, and public sector initiatives to preserve native ecosystems. H. Spoehr

FIELD TRIPS:

A. For educators, interpreters, and general public. Demonstration areas for chemical and mechanical control; insect quarantine facility; Special Ecological Areas (SEAS); plant problem areas, including ungulate removal sites and burns.

B. For managers. Same areas but emphasis on techniques, technical problems, costs and program problems and organization.

VI. INTRODUCED PLANTS IN THE ABSENCE OF UNGULATES
(J.D. Jacobi, Chairman)

28. Relationships between native and alien plants on oceanic islands with and without wild ungulates. M.D. Merlin and J.O. Juvik
29. Alien plant response to release from feral sheep browsing on Mauna Kea. P.G. Scowcroft and C.E. Conrad
30. Success of alien plants after feral goat and pig removal. C.P. Stone, P.K. Higashino, J.T. Tunison, L.W. Cuddihy, S.J. Anderson, J.D. Jacobi, T.J. Ohashi, and L.L. Loope
31. Plant import rules and regulations. S.J. Higa
32. Needs of ornamental industries. R.S.N. Yee and W.C. Gagne
33. Plant introduction needs of the Hawaiian sugar industry. R.V. Osgood and R.D. Wiemer
34. Needs of ranchers. J.G. Cran and K. Dillingham

VIII. CHOOSING WHICH PLANTS TO CONTROL IN NATIVE ECOSYSTEMS
(L.L. Loope, Chairman)

35. Stemming plant invasions: implementing a strategy versus traditional tactics. R.N. Mack and M.E. Moody
36. Rule-based decision making as a way to determine which species to control. K.W. Bridges
37. A manager's guide for controlling weeds in natural areas. D.D. Taylor
38. Evaluating proposed biological control programs for introduced plants. G.P. Markin

IX. ECOSYSTEM APPROACHES, EDUCATION, AND COMMUNITY INVOLVEMENT

(F.M. Pottenger, Chairman)

39. Control of alien plants in Special Ecological Areas (SEAs) in Hawai'i Volcanoes National Park. J.T. Tunison and C.P. Stone
40. Environmental education. J.W. Hawkins.
41. Community action plant control programs and the use of volunteers. E.Misaki and J.T. Tunison

X. DISCUSSION/SUMMARY (PANEL) (C.W. Smith, Chairman)

Cooperation and interaction, opposition to control, legislative needs, research and management needs, making control choices, educational needs. Interest group representatives. AUDIENCE PARTICIPATION WITH WRITTEN QUESTIONS (1HR MINIMUM).

SOCIETY ANNIVERSARY BOOKLETS STILL AVAILABLE

The Society still has a good supply of the anniversary booklets issued at the time of the 25th Anniversary (1949) and the 50th Anniversary (1974). They are available on request, and may be of interest particularly to members who have not seen them. They contain photographs, historical sketches, and the Society Constitution and By-laws as of those times. There is an insert with the latter booklet which up-dates these instruments to the present.

Further, the Society contributed to the publication of a paper by Dr. Harold L. Lyon, "Honolulu Can Have a Botanical Garden", which was issued as an Occasional Paper of the University of Hawaii. Subsequently, the Pacific Tropical Botanical Garden was established, but Dr. Lyon's paper still makes interesting reading. We have a supply of them, available for the asking.

NEW MEMBERS; LIFE MEMBER

The Society welcomed the following into membership at the regular meeting in October:

Mr. Tim Flynn, of Lawai, Kaua'i
Mr. Toshihiko Ikagawa, of Honolulu
Mr. Clyde Imada, of Honolulu
Mr. Joel Q. C. Lau, of Honolulu
Mr. Thomas M. Shields, of Kailua

Further, the Society congratulates Ms. Winona P. Char on her becoming a Life Member; she makes the 15th Life Member.

ARE YOU GETTING NOTICES OF MEETINGS?

Announcements of Regular Meetings are sent now to most of the members. However, the computerized data base shows that 24 members do not get such notices. Perhaps this is at their own request, as they are mostly members not on O'ahu. But off-island members are in town on meeting nights on occasion, and might want to get notices anyway. If you want to get them, and do not, please so advise us. (All members in good standing should be receiving the Newsletter.)

For this mailing of the Newsletter only, an additional symbol will appear on the mailing label after the dues and membership status symbols. The code "/y" means "yes"; you should be getting meeting notices now. The code "/n" means "no"; for some reason, we have not been mailing them to you. We can change that if you wish.

HALEAKALĀ SILVERSWORD

Betsey Harrison-Gagné reports that a total of 697 silversword flowered throughout Haleakalā National Park in the 1986 season. Flowering time generally ranges from May to October with peak flowering in the summer months. This year there are plants just initiating inflorescences in early November. Some plants are still in full bloom a week before Thanksgiving. The number of flowering silverswords is the third highest in the past five years that the Park has been making an annual flowering census.

MULLEIN DISCOVERED IN HALEAKALĀ NATIONAL PARK

On 2 October 1986, a single common mullein plant (Verbascum thapsus: Scrophulariaceae) was found growing along the roadside at 9000ft. It is currently a non-flowering individual about 8in. diameter. The Park has educated all employees to be on the lookout for any more plants so that any potential infestation can be controlled before it gets out of hand. The current specimen will be allowed to flower in order to verify the record. It will be immediately uprooted and made into a herbarium specimen.

Botanical Society members are asked to report any other plants that they may come across in the Park or adjacent areas, e.g., Polipoli Springs, to Ron Nagata at Haleakalā or to the State Forestry Office in Wailuku.

BOTANICAL SURVEY OF THE
KAHUKU TRAINING AREA, O'AHU, HAWAI'I

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Winona Char and Layne Yoshida
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3190 Maile Way
HONOLULU HI 96822

INTRODUCTION

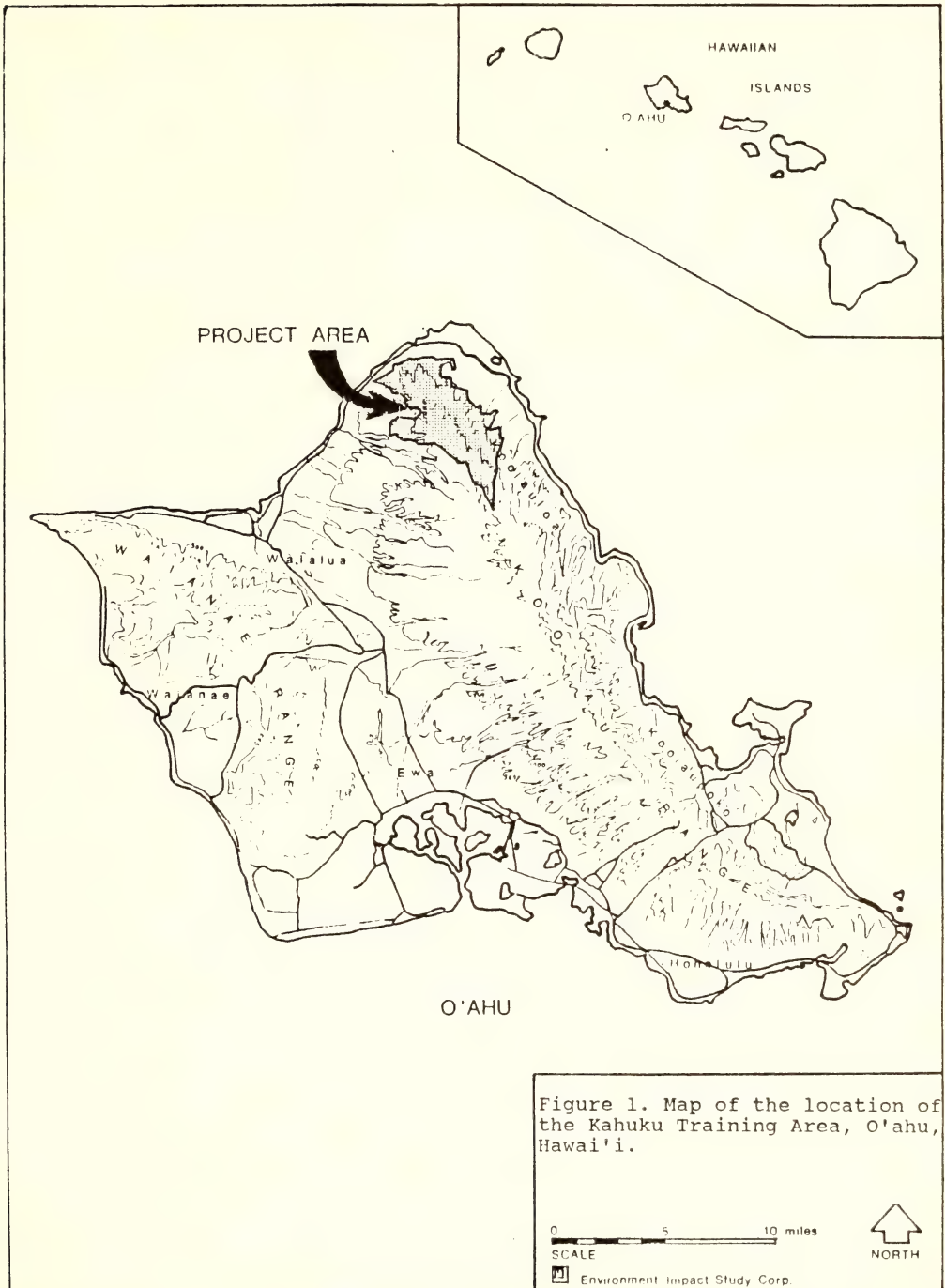
The Kahuku Training Area is located on the island of O'ahu, Hawai'i, at the northernmost portion of the Ko'olau Range (Figure 1). The training area, consisting of 9,646 acres, is presently leased by the Army from the State of Hawai'i and encompasses a mass of land extending from near sea level to the crest of the Ko'olau Range at an elevation of approximately 2,000 feet. Rainfall in the area increases rapidly with elevation and changes in vegetation types parallel the increase in rainfall.

A survey of the area was conducted in November and December, 1976, to inventory the flora, describe the major vegetation zones, search for rare and endangered plants, and identify areas of potential environmental problems or concerns. Ten man-days of fieldwork were required to gather technical data for this report.

METHODOLOGY

Prior to undertaking the field survey, a literature search was conducted and aerial photographs and maps were studied to determine representative sampling areas and to select access routes. Existing trails and jeep roads were used to gain access to these areas (Figure 2). An extension of the Summit Trail on the Ko'olau crest along the southwest border of the training area provided access to the predominately native crest vegetation. A jeep road on the Pūpūkea side of the training area within the Pūpūkea-Paumalū Forest Reserve was used to gain access to the forestry plantings and adjacent gulches. Access to the mid-elevation mixed mesic forest was gained from the roads within the reservation and from the Mālaekahana trail south of Hina Gulch. The lower areas were sampled from jeep trails that transected the area. Reconnaissance was made of all vegetation types delineated in preliminary vegetation maps prepared through photo interpretation of aerial photographs.

Species observed and notes on the vegetation of representative areas were recorded in the field. Collections were made of rare plants and of plants that could not be positively identified in the field. Binoculars were used to



survey areas that were impassable or dangerous. However, when interesting plants were sighted by binoculars, an attempt was made to collect a specimen for complete identification. Areas containing an abundance of native plant species or containing rare or endangered species were considered to be of the greatest interest, and the studies were concentrated in these areas.

A relative abundance scale was deemed inappropriate because of the extreme variations found in the sampling areas. Future studies in greater depth are necessary to prepare accurate abundance ratings for the Kahuku Training area.

DISCUSSION

Description of Areas Surveyed

The Kahuku Training Area was divided into four survey sections (Figure 2). The first section is the predominately native crest flora located along the southwest border of the training area and the Kahuku Forest Reserve. The second section consists of forestry plantings along the crest and adjacent gulches in the Pūpūkea-Paumalū Forest Reserve. The third section is the mid-elevation slopes in the Mālaekahana region. These slopes are further divided into two subsections because of distinct differences in vegetation between the ridges and the gulches. Subsection a is considered to be the ridge proper and subsection b the gulches. The fourth section is the lower area. The vegetation in this area is comprised primarily of exotic grasses.

Section 1

The vegetation of the ridges along the Ko'olau summit in the Kahuku Forest Reserve consist of a low canopy Metrosideros-Dicranopteris open forest, which is characteristic of the Ko'olau Crest. Acacia koa is co-dominant with Metrosideros up to an elevation of about 1,400 feet but no higher. In most areas the canopy is between 25 and 75 percent closed and 10 to 20 feet high. In addition to Metrosideros and Acacia koa, species common in the canopy layer are: Psychotria, Bobea, Antidesma, Eugenia sandwicensis and Psidium cattleianum. Interestingly, certain mesic forest species such as Diospyros, Elaeocarpus, Scaevola gaudichaudiana, Xylosma and Gardenia are found very near the summit along the crest trail in the same vicinity as such typical summit plants as Trematolobelia macrostachys and Clermontia persicifolia. The usual groundcover is a fern mat composed of Dicranopteris linearis. Clidemia, Freycinetia and Andropogon are found in areas not dominated by Dicranopteris.

In areas of great localized disturbance such as along the trails and near Helipad 9, the groundcover is dominated by

Andropogon virginicus. Also in some of these areas, Psidium cattleianum forms dense thickets and is the dominant woody plant. It appears that P. cattleianum is capable of spreading rapidly and can dominate areas where the Metrosideros canopy is broken. Throughout the area, standing trunks of dead Metrosideros are common. Whether these have died as a result of human disturbance, or due to damage by feral pigs, or a successional phenomenon, is unclear. Where the canopy of Metrosideros is broken, many of the epiphytes characteristic of the vegetation on the Ko'olau Crest disappear, and the vegetation is considerably different.

Section 2

Section 2 consists of the Pūpūkea-Paumalū Forest Reserve which is included in the Kahuku Training Area. The area is disturbed by several exotic plantings. Melaleuca and Eucalyptus are the major components of these plantings, in addition to other exotics such as Casuarina and Albizia. There is virtually no understory under the exotic tree cover. Most of the plantations are bordered by Dicranopteris, but whether this occurrence is natural or a result of the disturbance in the area is unclear.

Pockets of native vegetation can be found in the deep gulches located throughout the area. In these areas, which are representative of the mid-elevation mixed mesic forest (described in the following section), there remain native plants of interest. Species such as Cyanea, Rauvolfia, Xanthoxylum and the endangered Ochrosia compta are present. Other plant in the area are species of Pittosporum and Tetraplasandra. The rugged terrain and steep valley walls made access to some of these areas impossible.

Acacia koa is common along the sides of the jeep trails and there are a few areas along the jeep trail on the crest where Santalum freycinetianum can be found. The Acacia koa trees in the area are stunted and many of the plants appear to be on the verge of falling over.

Andropogon virginicus is prevalent in some of the disturbed areas. Several conspicuous areas of open grassland surrounded by open canopy forest were noted. These grasslands appeared to be the result of fire. Two areas were in both cases, Andropogon virginicus was the first plant to colonize the area.

Section 3

The mid-elevation slopes of the training area are dissected by many gulches with the flora on the ridges (section 3a in the species list) differing from the flora in the gulches (section 3b in the species list). At approximately 600 foot elevation, grass and shrubland communities give way to a community dominated by Acacia koa and Metrosideros. Other

plants found in the area are: Eugenia sandwicensis, Psychotria, Diospyros, Bobea, Planchonella, Pittosporum, Xylosma and other native mesic forest species, as well as dense thickets of Psidium cattleianum.

The steeper sides of the ridges are covered with Dicranopteris, with other vegetation similar to that of the ridge tops, and grading into the Aleurites dominated forests of the gulches and subgulches. Eugenia jambos and Pisonia Charpentiera, Pipturus, Cyrtandra and several species of fern are found in the understory.

Section 4

The most heavily used parts of the Kahuku Training Area are the lower slopes that are covered by open grassland with scattered scrub. Andropogon virginicus is the predominant species of grass forming the open grassland communities of the area. Other species also form noticeable components of the grassland. These include Brachiaria mutica and Melinis minutiflora along the jeep trails and on the fringes of the recently eroded areas. Portions of the lower area of the Kahuku Training Area were once planted in sugar, and abandoned patches still remain in the open grassland.

Schinus terebinthifolius and Psidium guajava are the most abundant scrub species present in areas adjoining the grassland with Casuarina, Eugenia cuminii, Scaevola gaudichaudiana, Wikstroemia, Morinda citrifolia and patches of Cordyline terminalis also being common.

The gulches of the lower area contain specimens of Pittosporum and Dracaena, and in one gulch four individuals of Reynoldsia sandwicensis were found. The cluster of our trees was located 20 yards off one of the jeep trails. One of the trees was extremely large, being approximately 45 feet tall, with an approximate diameter of 3 1/2 feet at breast height.

Description of Vegetation Types

Vegetation delineations for the Kahuku Training Area were prepared through interpretation of high altitude color infrared photographs and verified by the field survey. On the basis of the photo-interpretations and the field survey conducted in November and December, 1976, the following vegetation types have been recognized in the Kahuku training Area (Figure 3).

Open Grassland.--This vegetation type can be further separated into two subtypes. In both instances the vegetation subtypes are present as a result of considerable disturbance and rarely are native plants found in either subtype.

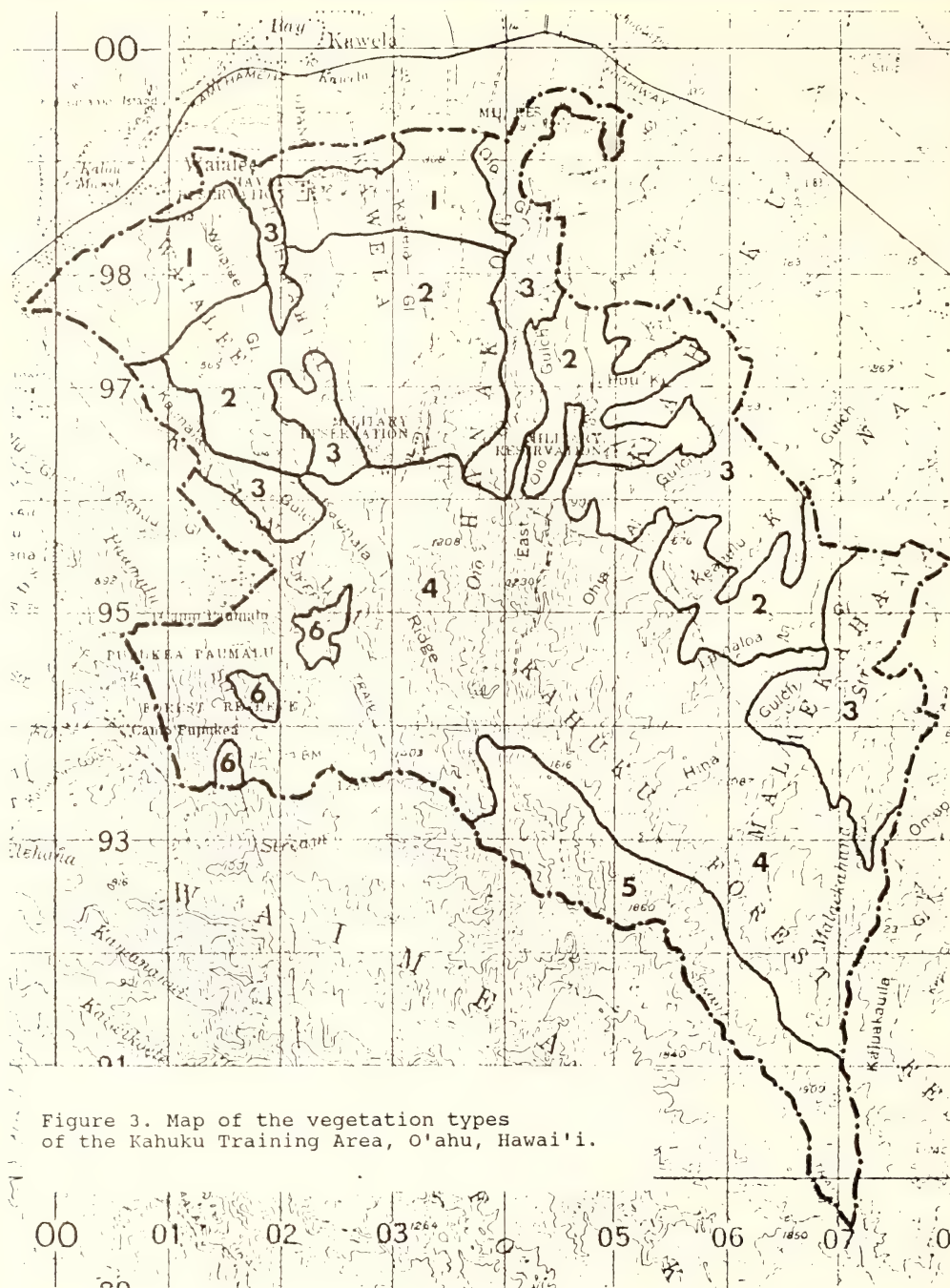


Figure 3. Map of the vegetation types of the Kahuku Training Area, O'ahu, Hawai'i.

Open Grassland at Low Elevations.--This vegetation type is roughly equivalent to area 1 on Figure 3. Andropogon virginicus is the predominant species in the community at low elevations, but Brachiaria mutica and Melinis minutiflora may form distinct stands on their own. Patches of Saccharum are also evident. This subtype covers the lower areas of the Kahuku Training Area, and grades into the grass scrubland.

Open Grassland Communities at the Ko'olau Crest.--At the higher elevations of the Kahuku Training Area open grasslands are found in disturbed areas such as at Helipad 9, along parts of the trail, and in areas where there has been much troop activity. These areas are small, and therefore not noted on the vegetation map, but deserve special recognition. The dominant grass species is Andropogon, but Paspalum conjugatum, Sacciolepis and Setaria geniculata are also abundant.

Mixed Scrub-grassland.--The vegetation type present at low elevations is equivalent to area 2 on Figure 3. This vegetation type is a transition between the open grassland and the lowland scrub. It includes species present in both.

Lowland Scrub/Lowland Scrub Forest.--This community, area 3, is characterized by Schinus and Psidium guajava. This community is predominantly scrub, but several species present can become trees. This vegetation type is present on the slopes and gullies of the lowlands that are not dominated by the open grassland and grades into the mixed mesic forest at middle elevations. Other exotic species in this community are Psidium cattleianum, Lantana, Leucaena and Acacia confusa which normally form shrubs in this ecotone. Eugenia cuminii, Casuarina, Brassia, Aleurites and Mangifera are capable of forming sizeable trees. These areas are generally less disturbed than the grasslands, and native species that are frequently present include Osteomeles, Scaevola gaudichauniana, Styphelia, Dodonaea, Wikstroemia, Canthium, Xanthium, Santalum freycinetianum and Hibiscus tiliaceus. The vegetation in the gulches at the lower elevations in the Kahuku Training Area is essentially that of the lowland scrub forest and may be of variable density and species composition. A few patches of bamboo were seen at a distance in this area.

Mixed Mesic Forest.--This vegetation type, area 4, is made up of two subtypes: ridges and gulches. There are transitions between the two subtypes as there are between this vegetation type and both the Lowland Scrub Forest and the Crest Vegetation.

Mixed Mesic Ridge Vegetation.--This subtype is made up of many mesic forest species and is found on the ridges and upper slopes of middle elevation in the Kahuku Training

Area. Dominant species present include Metrosideros and Acacia koa, and in many areas it is not possible to recognize a dominant species. Other species common in the area are Eugenia sandwicensis, Santalum freycinetianum, Xylosma, Aleurites, Psychotria, Bobea, Canthium, Osmanthus, Diospyros, Pittosporum, Rauvolfia, and Scaevola gaudichaudiana. Dicranopteris is the common groundcover on steep slopes. In the less sloping areas there is almost 100% cover by trees, and little groundcover, though a few ferns, sedges, and grasses can be found. Exotic species in the area include dense thickets of Psidium cattleianum located throughout the area. Pockets of Albizia and Ardisia are located in the transitional zone between this vegetation subtype and the Crest Vegetation.

Mixed Mesic Gully Vegetation.--Kukui, Pisonia and Eugenia are the most abundant canopy species, and Charpentiera, Pipturus, Cyrtandra and several species of fern were found in the understory. It was interesting to note the absence of thick stands of Clidemia in some of the secondary gullies on the windward side of the Ko'olau range especially since it is very common on the crest. At the same elevation on the leeward side of the Ko'olau range, the gulches are choked with this weed.

Crest Vegetation

This vegetation type is included under code 5 on the prepared vegetation map. The crest vegetation is the vegetation type typical of the Ko'olau Crest, but as the Kahuku Training Area is in the northernmost part of the Ko'olau where the crest is poorly defined, the crest vegetation in this area is atypical of the rest of the Ko'olau. Species not usually characteristic of this zone such as Diospyros, Elaeocarpus, Gardenia, Scaevola gaudichaudiana, and Xylosma, are mixed with species typical of the crest including Trematolobelia macrostachys, and Clermontia persicifolia. Other native species present in the area are Metrosideros, Psychotria, Bobea, Antidesma, Eugenia sandwicensis, Cheirodendron trigynum, Tetraplasandra and Gouldia. Exotic species common in the area are Psidium cattleianum, Clidemia, and Leptospermum.

Exotic Plantation

This easily recognized vegetation type is coded 6 on the vegetation map. It occurs in several areas at mid-elevation in the Kahuku Training Area. The species present include Albizia, Melaleuca and several species of Eucalyptus. There is little understory in this vegetation type.

RARE PLANTS

One plant in the Kahuku Training Area was positively identified as being included in the Federal Register of

Endangered and Threatened Species (1976). This was Ochrosia compta. The plant was found on the side of a gulch in one of the forest plantations. It is a tree about 25ft tall with an approximate diameter at breast height of 6in. Other species in the area include Melaleuca which forms the canopy layer, Psidium cattleianum, Psychotria, Clidemia and Diospyros, with Athyrium japonicum and A. prolificum being the predominant groundcover.

In addition to the Ochrosia, there are two species of Tetraplasandra recorded (Sherff 1955) from the Kahuku Training Area which are on the list of plants proposed for endangered status. These are T. gymnocarpa var. pupukeensis, and T. pupukeensis. Positive identification of specimens was not possible because the plants lacked parts necessary for complete identification, and many of the species are poorly defined. The identification of the group is difficult and has been called "taxonomically nearly hopeless" by the authors of the Allertonia list of rare and endangered plants (Fosberg and Herbst 1975).

One other plant deserves mention in this section. The extremely large Reynoldsia sandwicensis was found in a gulch in the lower region of the Kahuku Training Area. This species is depleted throughout much of its former range, however, there are still populations on O'ahu but not in the Ko'olau Range, and no individuals with a diameter at breast height of 3-1/2 feet. The species is not presently a new local record. Its diameter is considerably greater than that given for the "champion" Reynoldsia by Bryan (1944), and care should be taken to insure its protection. Fires originating from activities in grassland in the lower areas of the reserve could easily spread to the gulch and destroy the small population of these trees. This might be prevented by a firebreak between the grassland and the gulch.

LIMITATIONS OF THE SURVEY

This survey is a preliminary assessment of the Kahuku Training Area. The lower grasslands are no longer floristically interesting, but more intensive study could be conducted in lowland gulches.

Rugged terrain prevented an adequate survey of the middle elevation slopes and gulches; it is these areas that appear to be the most floristically promising areas in the reservation for native species. In such areas Pisonia, Charpentiera, and Cyanea can be found. Only one species of each of these plants was collected, and other species can probably be found along with other species of Cyrtandra and various ferns. Pteralyxia macrocarpa was reported in the area (Caum 1933) but was not observed in this survey. One rare plant, Ochrosia, was found on the middle elevation slopes and others are likely present. The mesic forest on the slopes and gulches of the eastern

section of the Kahuku Training Area are potential areas for additional botanical surveys.

The crest was more extensively surveyed than the middle elevation slopes. Plants that have been collected there formerly, or noted from similar areas south of the Kahuku Training Area, were either not seen, or overlooked. Such plants include species of Tetraplasandra and Phyllostegia (Sherff 1935).

REFERENCES

Literature dealing specifically with the vegetation of the Kahuku Training Area is limited, but literature dealing with particular genera occurring in the area was used extensively. The following (denoted by an asterisk) were consulted for descriptions of vegetation, and for identification of several groups.

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SPECIES CHECKLIST

Families are listed alphabetically within each of four groups: Pteridophyta, Gymnospermae, Monocotyledonae and Dicotyledonae. Genera and species are arranged alphabetically. Taxonomy and nomenclature of pteridophytes follow Wagner's unpublished Checklist of Hawaiian Pteridophytes except where more commonly accepted names are listed. Taxonomy and nomenclature of flowering plants follow St. John (1973). Common Hawaiian names used in the checklist are in accordance with Porter (1972) or St. John (1973).

For each species the following information is provided:

1. Scientific name.
2. Vernacular name, when commonly used, or Hawaiian name when known.
3. Status of the species. The following symbols are employed:

- E endemic to the Hawaiian Islands, i.e. occurring naturally nowhere else in the world.
- I indigenous, i.e., native to the Hawaiian Islands but also occurring naturally (without the aid of man) elsewhere.
- X alien, i.e., plants of accidental or deliberate introduction after the Western discovery of the islands.
- P Polynesian introduction; it includes those plants brought by the Polynesian immigrants previous to Captain Cook's discovery of the islands.

4. Federal Register (FR) Federal Register entry, June 16, 1976.
- E Endangered (a taxon which is in danger of extinction throughout all or a significant portion of its range--def. from Pub. Law 93205).
- * plant taxon for which information on living specimens is especially desired (by U. S. Fish and Wildlife Service Office of Endangered Species).
5. F. R. Fosberg and Derral Herbst (FH) - Listing of rare and endangered species of Hawaiian vascular plants.

A list of symbols and their explanations are given below:

- EX extinct
- R rare, total population low, whether dangerously so or not
- L local, found only or principally in one or more restricted areas
- D depleted, much less common over all or most of its range than formerly, the depletion directly or indirectly the result of human activities
- EN endangered, in considerable danger of disappearance
- C in cultivation
- W having a wider distribution than the Hawaiian Islands, corresponding to St. John's use of the term "indigenous" in his list
- U uncertain, insufficient information available to us to decide if endangered
- P protected
- DE population apparently decreasing
- S population apparently stable
- I population apparently increasing
- v very
- o only
- pr probably
- po possibly

6. The presence of species within the study sites is denoted with an (X) mark. A relative abundance scale was not used in the study since this area was considered too varied.
7. The locality symbol used above each abundance column represents:
- 1 Ko'olau Crest
- 2 Pūpūkea-Paumalū Forest Reserve
- 3a Mid-elevation Ridges
- 3b Mid-elevation Slopes
- 4 Lower-elevation Slopes

CHECK LIST OF PLANTS KARUKU TRAINING AREA, O'AHU, HAWAIIAN ISLANDS

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE			
PTERIDOPHYTA					1	2	3a	3b 4
ADIANTACEAE								
<u>Pityrogramma calomelanos</u> (L.) Link	Gold fern, silver fern	X					X	X X
ASPLIDIACEAE								
<u>Athyrium japonicum</u> (Thumb.) Copel.		I				X		
<u>A. proliferum</u> (Kaulf.) C. Chr.		I				X	X	X
<u>Cyclosorus cyatheoides</u> (Kaulf.) Farwell		E				X	X	X
<u>C. dentatus</u> (Forsk.) Ching	Downy wood-fern	I				X	X	
<u>C. parasiticus</u> (L.) Farwell		X						X
<u>Dryopteris stegogrammoides</u> (Bak.) C. Chr.	Ho'i'o-kula	E					X	X
<u>Elaphoglossum alatum</u> Gaud.	'Ekaha	E				X		
<u>E. crassifolium</u> Anderson & Crosby	'Ekaha	E				X	X	
ASPLENIACEAE								
<u>Asplenium lobulatum</u> Mett.	'Anali'i	I				X		
<u>A. nidus</u> L.	Bird's nest fern, 'ekaha	I				X	X	
BLECHNACEAE								
<u>Blechnum occidentale</u> L.		X				X		
<u>Doodia kunthiana</u> Gaud.	'Okupukupu, 'okupukupu-lau'i'i	E					X	X X
DAVALLIACEAE								
<u>Nephrolepis cordifolia</u> (L.) Presl	'Okupukupu, pamoho	I				X	X	
<u>N. exaltata</u> (L.) Schott	Sword fern, pamoho	I				X	X	X
<u>N. hirsutula</u> (Forsk.) Presl	Kupukupu	X						X

Kahuku Training Area Plant Checklist (cont.)

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE			
					1	2	3a	3b 4
DENNSTAEDTIACEAE								
<u>Microlepia strigosa</u> (Thunb.) Presl	Palai, palapalai	I						X
<u>Pteridium aquilinum</u> var. <u>decompositum</u> (Gaud.) Tryon	Kilau	E					X	X X
DICKSONIACEAE								
<u>Cibotium chamissoi</u> Kaulf.	Hapu'u'i'i	E				X	X	X
<u>C. glaucum</u> (Sm.) H. & A.	Hapu'u	E					X	
<u>C. splendens</u> (Gaud.) Krajina	Hapu'u pulu	E				X	X	X
GLEICHENIACEAE								
<u>Dicranopteris linearis</u> (Burm.) Underw.	Uluhe, uluhi	I				X	X	X X
GRAMMITIDACEAE								
<u>Adenophorus tamariscinus</u> (Kaulf.) H. & Grev.	Wahine-noho-mauna	E				X	X	X
<u>Grammitis tenella</u> Kaulf.	Kolokolo, mahina-lua	E				X	X	
HYMENOPHYLLACEAE								
<u>Meconium recurvum</u> (Gaud.) Copel.	'Ohi'a ku	E				X	X	
<u>Sphaerocionium lanceolatum</u> (H. & A.) Copel.	Palai-lau-li'i, palai hinahina	E					X	
<u>S. obtusum</u> (H. & A.) Copel.	Palai-lau-li'i, palai hinahina	E				X	X	
<u>Vandenboschia davallioides</u> (Gaud.) Copel.	Kilau, Palai-hihi	E					X	
LINDSAYACEAE								
<u>Sphenomeris chinensis</u> (L.) Maxon	Pala'a, palapala'a	I					X	X
LYCOPODIACEAE								
<u>Lycopodium cernuum</u> L.	Club moss, wawae-iolo	I				X	X	
<u>L. phyllanthum</u> H. & A.	Club moss, wawae-iolo	I						X

OPHIOGLOSSACEAE					
<u>Ophiglossum pendulum</u> L.	Lau-kahi, puapua-moa	I		X	X
POLYPODIACEAE					
<u>Microsorium scolopendria</u> (Burm.) Copel.	Laua'e, lauwa'e	X			X
<u>Phlebodium aureum</u> (L.) J. Smith	Laua'e haole	I		X	
PSILOTAACEAE					
<u>Psilotum complanatum</u> Sw.	Moa	I		X	X
<u>P. nudum</u> (L.) Beauv.	Moa	I		X	X
GYMNOSPERMAE					
ARAUCARIACEAE					
<u>Araucaria columnaris</u> (Forst. f.) Hook.	Cook pine	X		X	X
PINACEAE					
<u>Pinus radiata</u> D. Don	Monterey pine	X			X
<u>Pinus</u> sp.		X			X
MONOCOTYLEDONAE					
ARACEAE					
<u>Colocasia esculenta</u> var. <u>antiquorum</u> (Schott) Hubb. & Rehd.	Taro, kalo	P		X	X
<u>Philodendron</u> sp.		X		X	
<u>Scindapsus aureus</u> (Lind. ex Andre') Engl.	Taro vine	X		X	
COMMELINACEAE					
<u>Commelina diffusa</u> Burm. f.	Honohono	X		X	X
CYPERACEAE					
<u>Carex meyenii</u> Nees		E		X	X
<u>C. wahuensis</u> C. A. Mey.		E		X	X
<u>Cyperus brevifolius</u> (Rottb.) Hassk.	Kyllinga, kili'o'opu	X		X	X
<u>C. javanicus</u> Houtt.	Marsh cypress, 'ahu'awa	I?		X	
<u>Eleocharis obtusa</u> var. <u>gigantea</u> (Clarke) Fern.	Kohekohe, pipi'wai	I?		X	
<u>Gahnia beecheyi</u> Mann	'Uki	E		X	
<u>G. globosa</u> Mann		E	U		X

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE				
					1	2	3a	3b	4
DENNSTAEDTIACEAE									
<i>Microlepia strigosa</i> (Thunb.) Presl	Paloi, palapalai	I							X
<i>Pteridium aquilinum</i> var. <i>decompositum</i> (Gaud.) Tryon	Kilau	E						X	X X
DICKSONIACEAE									
<i>Cibotium chamissoi</i> Kaulf.	Hapu'u'i'i	E					X	X	X
<i>C. glaucum</i> (Sm.) H. & A.	Hapu'u	E						X	
<i>C. splendens</i> (Gaud.) Kragina	Hapu'u pulu	E					X	X	X X
GLEICHENIACEAE									
<i>Dicranopteris linearis</i> (Burm.) Underw.	Uluhe, uluhi	I					X	X	X X X
GRAMMITIDACEAE									
<i>Adenophorus tamariscinus</i> (Kaulf.) H. & Grev.	Wahine-noho-mauna	E					X	X	X X
<i>Grammitis tenella</i> Kaulf.	Kotokolo, mahina-lua	E					X	X	
HYMENOPHYLLACEAE									
<i>Hecordium recurvum</i> (Gaud.) Copel.	'Ohi'a ku	E					X	X	
<i>Sphaeroclonium lanceolatum</i> (H. & A.) Copel.	Palai-lau-tii'i, palai hinahina	E						X	
<i>S. obtusum</i> (H. & A.) Copel.	Palai-lau-tii'i, palai hinahina	E					X	X	
<i>Vandenboschia davallioides</i> (Gaud.) Copel.	Kilau, Palai-hihi	E						X	
LINDSAEACEAE									
<i>Sphenomeris chinensis</i> (L.) Maxon	Pala'a, palapala'a	I						X	X
LYCOPODIACEAE									
<i>Lycopodium cernuum</i> L.	Club moss, wawae-iolo	I					X	X	
<i>L. phyllanthum</i> H. & A.	Club moss, wawae-iolo	I						X	
OPHIOGLOSSACEAE									
<i>Ophioglossum pendulum</i> L.	Lau-kahi, puapua-moa	I					X	X	
POLYPODIACEAE									
<i>Microsorium scolopendria</i> (Burm.) Copel.	Laua'e, lauwa'e	X							X
<i>Phlebodium aureum</i> (L.) J. Smith	Laua'e haole	I					X		
PSILOTAACEAE									
<i>Psilotum complanatum</i> Sw.	Moa	I					X	X	
<i>P. nudum</i> (L.) Beauv.	Moa	I					X	X	X X X
GYMNOSPERMAE									
ARAUCARIACEAE									
<i>Araucaria columnaris</i> (Forst. f.) Hook.	Cook pine	X						X	X
PINACEAE									
<i>Pinus radiata</i> D. Don	Monterey pine	X							X
<i>Pinus</i> sp.		X							X
MONOCOTYLEDONAE									
ARACEAE									
<i>Colocasia esculenta</i> var. <i>antiquorum</i> (Schott) Hubb. & Rehd.	Taro, kalo	P							X X
<i>Philodendron</i> sp.		X						X	
<i>Scindapsus aureus</i> (Lind. ex Andre') Engl.	Taro vine	X						X	
COMMELINACEAE									
<i>Commelina diffusa</i> Burm. f.	Honohono	X						X	X X
CYPERACEAE									
<i>Carex meyerii</i> Nees		E					X	X	X
<i>C. wahuensis</i> C. A. Mey.		E						X	X
<i>Cyperus brevifolius</i> (Rottb.) Hassk.	Kyllinga, kili'o'opu	X					X	X	X X
<i>C. javanicus</i> Houtt.	Marsh cypress, 'ahu'awa	I?						X	
<i>Eleocharis obtusa</i> var. <i>gigantea</i> (Clarke) Fern.	Kohekohe, pipiwai	I?					X		
<i>Gahnia beecheyi</i> Mann	'Uk	E						X	
<i>G. globosa</i> Mann		E		U					X

Kahuku Training Area Plant Checklist (cont.)

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE			
					1	2	3a	3b 4
CYPERACEAE continued								
<i>Machaerina angustifolia</i> (Gaud.) Koyama	'Uki	I				X		
<i>M. mariscoides</i> ssp. <i>Meyenii</i> (Kunth) Koyama	'Uki, aha-niu	I				X	X	X
<i>Rhynchospora lamarum</i> Gaud.	Kuolohia, pu'uka'a	E				X	X	X
DIOSCOREACEAE								
<i>Dioscorea bulbifera</i> L.	Bitter yam, hoi	P				X		
<i>D. pentaphylla</i> L.	Pi'a	P				X		X
GRAMINEAE								
<i>Andropogon aristatus</i> Poir.	Wilder grass	X						X
<i>A. virginicus</i> L.	Broomsedge	X				X	X	X
<i>Axonopus affinis</i> Chase	Narrow-leaved carpetgrass	X						X
<i>Bambusa</i> sp.	Bamboo	X					X	X
<i>Bracharia mutica</i> (Forsk.) Stapf	Paragrass, California-grass	X					X	X
<i>Cenchrus echinatus</i> L.	Common sandbur, 'ume 'alu	X						X
<i>Chloris inflata</i> Link	Swollen fingergrass	X						X
<i>C. radiata</i> (L.) Sw.	Radiate fingergrass	X						X
<i>C. virgata</i> Sw.	Feather fingergrass	X						X
<i>Chrysopogon aciculatus</i> (Retz.) Trin.	Golden beardgrass, pilipili-'ula	X						X
<i>Digitaria pruriens</i> (Fisch. ex Trin.) Buse	Kukae-pua'a	X						X
<i>Eleusine indica</i> (L.) Gaertn.	Goosegrass, wiregrass, manienie ali'i	X					X	X
<i>Heteropogon contortus</i> (L.) Beauv.	Twisted beardgrass, pili, pili grass	I						X
<i>Hypparrhenia rufa</i> (Nees) Stapf	Thatching grass, jaraqua	X				X		
<i>Melinis minutiflora</i> Beauv.	Molassesgrass	X						X
<i>Oplismenus hirtellus</i> (L.) Beauv.	Basketgrass, honohono kukui	X				X	X	X
<i>Panicum maximum</i> Jacq.	Guinea grass	X						X
<i>Paspalum conjugatum</i> Berg.	Hilo grass, mau'u malihini	X				X	X	X
<i>P. fimbriatum</i> HBK.	Panama paspalum	X						X
<i>P. orbiculare</i> Forst. f.	Ricegrass, Mau'u laiki	X					X	X

<u>Pennisetum clandestinum</u> Hochst.	Kikuyugrass	X			X
<u>P. purpureum</u> Schumacher	Napiengrass	X			X
<u>P. setosum</u> (Sw.) L. C. Rich	Feathery pennisetum	X			X
<u>Polypogon interruptus</u> HBK.	Ditch polypogon	X			X
<u>Rhynchelytrum repens</u> (Willd.) C. E. Hubb.	Natal redtop	X			X
<u>Saccharum officinarum</u> L.	Sugar cane, ko	P			X
<u>Sacciolepis indica</u> (L.) Chase	Glenwoodgrass	X		X	X
<u>Setaria geniculata</u> (Poir.) Beauv.	Perennial foxtail, Mau'u	X		X	X
	kaleponi	X		X	X
<u>S. palmaefolia</u> (Koen.) Stapf	Palmgrass	X		X	
<u>Sporobolus africanus</u> (Poir.) Robyns & Tourney	African dropseed	X			X
<u>Zoysia tenuifolia</u> Willd.	Japanese lawngrass	X			X
LILIACEAE					
<u>Cordyline terminalis</u> (L.) Kunth	Ti, ki	P		X	X
<u>Dianella sandwicensis</u> H. & A.	'Uki 'uki	E		X	X
<u>Pleomele aurea</u> (H. Mann) N.E. Br.	Hala pepe	E	D, EN, C	X	X
MUSACEAE					
<u>Musa</u> sp.	banana, mai'a	X?P?		X	X
ORCHIDACEAE					
<u>Arundina bambusaefolia</u> (Roxb.) Lindl.		X		X	X
<u>Spathoglottis plicata</u> Bl.		X		X	X
PALMAE					
<u>Phoenix</u> sp.	Date palm	X			X
<u>Pritchardia</u> sp.	Loulu	E		X	
<u>Roystonea</u> sp.		X		X	
PANDANACEAE					
<u>Freycinetia arborea</u> Gaud.	'Ie'ie	E		X	X
<u>Pandanus</u> sp.	Screw pine, hala	P			X
ZINGIBERACEAE					
<u>Zingiber zerumbet</u> (L.) Roscoe	'Awapuhi kua hiwi, 'opuhi	P		X	X

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE				
					1	2	3a	3b	4
CYPERACEAE continued									
<i>Machaena angustifolia</i> (Gaud.) Koyama	'Uki	I					X		
<i>M. mariscoides</i> ssp. <i>Meyenii</i> (Kunth) Koyama	'Uki, aha-niu	I					X	X	X
<i>Rhynchospora Lavarum</i> Gaud.	Kuolohia, pu'uka'a	E					X	X	X
DIOSCOREACEAE									
<i>Dioscorea bulbifera</i> L.	Bitter yam, hoi	P					X		
<i>D. pentaphylla</i> L.	Pi'a	P					X	X	
GRAMINEAE									
<i>Andropogon aristatus</i> Poir.	Wilder grass	X							
<i>A. virginicus</i> L.	Broomsedge	X					X	X	X
<i>Axonopus affinis</i> Chase	Narrow-leaved carpetgrass	X							X
<i>Bambusa</i> sp.	Bamboo	X						X	X
<i>Brachiaria mutica</i> (Forsk.) Stapf	Paragrass, California-grass	X						X	X
<i>Cenchrus echinatus</i> L.	Common sandbur, 'ume 'alu	X							X
<i>Chloris inflata</i> Link	Swollen fingergrass	X							X
<i>C. radiata</i> (L.) Sw.	Radiate fingergrass	X							X
<i>C. virgata</i> Sw.	Feather fingergrass	X							X
<i>Chrysopogon aciculatus</i> (Retz.) Trin.	Golden beardgrass, pilipili-'ula	X							X
<i>Digitaria pruriens</i> (Fisch. ex Trin.) Buse	Kukae-pua'a	X							X
<i>Eleusine indica</i> (L.) Gaertn.	Goosegrass, wiregrass, manienie alii	X						X	X
<i>Heteropogon contortus</i> (L.) Beauv.	Twisted beardgrass, pili, pili grass	I							X
<i>Hyparrhenia rufa</i> (Nees) Stapf	Thatching grass, jaraqua	X					X		
<i>Melinis minutiflora</i> Beauv.	Molassesgrass	X							X
<i>Opismenus hirtellus</i> (L.) Beauv.	Basketgrass, honohono kukui	X					X	X	X
<i>Panicum maximum</i> Jacq.	Guinea grass	X							X
<i>Paspalum conjugatum</i> Berg.	Hilo grass, mau'u malihini	X					X	X	X
<i>P. fimbriatum</i> HBK.	Panama paspalum	X							X
<i>P. orbiculare</i> Forst. f.	Ricegrass, Mau'u laiki	X					X	X	X
<i>Pennisetum clandestinum</i> Hochst.	Kikuyugrass	X							X
<i>P. purpureum</i> Schumacher	Hapiergrass	X							X
<i>P. setosum</i> (Sw.) L. C. Rich	Feathery pennisetum	X							X
<i>Polypogon interruptus</i> HBK.	Ditch polypogon	X					X		
<i>Rhynchelytrum repens</i> (Willd.) C. E. Hubb.	Natal redtop	X						X	X
<i>Saccharum officinarum</i> L.	Sugar cane, ko	P							X
<i>Sacciolepis indica</i> (L.) Chase	Glenwoodgrass	X					X	X	X
<i>Setaria geniculata</i> (Poir.) Beauv.	Perennial foxtail, Mau'u kaleponi	X					X	X	X
<i>S. palmaefolia</i> (Koen.) Stapf	Palmgrass	X					X		
<i>Sporobolus africanus</i> (Poir.) Robyns & Tournay	African dropseed	X							X
<i>Zoysia tenuifolia</i> Willd.	Japanese lawngrass	X							X
LILIACEAE									
<i>Cordyline terminalis</i> (L.) Kunth	Ti, ki	P					X	X	X
<i>Dianella sandwicensis</i> H. & A.	'Uki 'uki	E					X	X	X
<i>Pleomele aurea</i> (H. Mann) N.E. Br.	Hala pepe	E		D,EN,C			X	X	X
MUSACEAE									
<i>Musa</i> sp.	banana, mai'a	X?	P?				X	X	X
ORCHIDACEAE									
<i>Arundina bambusaefolia</i> (Roxb.) Lindl.		X						X	
<i>Spathoglottis plicata</i> Bl.		X					X	X	X
PALMAE									
<i>Phoenix</i> sp.	Date palm	X							X
<i>Pritchardia</i> sp.	Loulu	E					X		
<i>Roystonea</i> sp.		X					X	X	
PANDANACEAE									
<i>Freyinetia arborea</i> Gaud.	'Ie'ie	E					X	X	X
<i>Pandanus</i> sp.	Screw pine, hala	P							X
ZINGIBERACEAE									
<i>Zingiber zerumbet</i> (L.) Roscoe	'Awapuhi kua hiwi, 'opuhi	P					X		X

Kahuku Training Area Plant Checklist (cont.)

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE			
					1	2	3a	3b 4
DICOTYLEDONAE								
AMARANTHACEAE								
<u>Charpentiera tomentosa</u> Schner	Papala	E					X	
ANACARDIACEAE								
<u>Mangifera indica</u> L.	Mango, manako	X				X	X	X
<u>Schinus terebinthifolius</u> Raddi	Christmas berry, wilelaiki	X			X		X	X
APOCYNACEAE								
<u>Alyxia olivaeformis</u> Gaud.	Maile	E			X	X	X	X
<u>Ochrosia compta</u> K. Schum.	Holei	E		D, R, En, C		X		
<u>Rauvolfia sandwicensis</u> A. DC.	Hao	E				X	X	
AQUIFOLIACEAE								
<u>Illex anomala</u> H. & A.	Kawa'u	E			X	X	X	
ARALIACEAE								
<u>Brassaia actinophylla</u> Endl.	Umbrella tree, octopus tree	X				X	X	X
<u>Cheirodendron trigynum</u> var. <u>Fosbergii</u> Sherff?	Olapa	E				X		
<u>Reynoldsia sandwicensis</u> Gray	'Ohe makai, 'ohe-o-kai	E						X
The genus <u>Tetraplasandra</u> is taxonomically poorly understood. Therefore, the following Hawaiian <u>Tetraplasandra</u> species are drawn from Sherff (1955). they have been collected from this area previously. The taxa are primarily found in study sites 1 and 2.								
<u>Tetraplasandra gymnocarpa</u> (Hbd.) Sherff	'Ohe	E		D				
<u>I. gymnocarpa</u> var. <u>pupukeensis</u> (Deg.) Sherff	'Ohe	E		EN				
<u>I. meiantha</u> var. <u>longipedunculata</u> Skotts.	'Ohe	E		D, U				
<u>I. pupukeensis</u> Skotts.	'Ohe	E		E				
<u>I. pupukeensis</u> var. <u>decipiens</u> Deg. & Sherff	E	E		E			VL, EN, R, C	
<u>I. pupukeensis</u> var. <u>megalopoda</u> Sherff	'Ohe	E						

<u>I. pupukeensis</u> var. <u>megaloopoda</u> f. <u>trigona</u> Deg. & Sherff	'Ohe	E			
<u>I. pupukeensis</u> var. <u>venosa</u> Deg. & Sherff	'Ohe	E		D, R, U, PoEN	
<u>Tetraplasandra</u> sp.	'Ohe	E		X	
<u>Tetraplasandra</u> sp.	'Ohe	E		X	
<u>Tetraplasandra</u> sp.	'Ohe	E		X	
<u>Tetraplasandra</u> sp.	'Ohe	E		X	
<u>Tetraplasandra</u> sp.	'Ohe	E			X
<u>Tetraplasandra</u> sp.	'Ohe	E		X	
BIGNONIACEAE					
<u>Spathodea campanulata</u> Beauv.	African tulip tree	X		X	X
CASUARINACEAE					
<u>Casuarina equisetifolia</u> Stickm.	Common ironwood, paina	X		X	X
<u>C. glauca</u> Sieb.	Longleaf ironwood	X		X	X
CELASTRACEAE					
<u>Perrottetia sandwicensis</u> Gray	Olomea	E		X	X
COMPOSITAE					
<u>Acanthospermum australe</u> (Loefl.) Ktze.	Spiny-bur, star-bur, kukae-hipa	X			X
<u>Adenostemma lavenia</u> (L.) Ktze.	Kamanamana	I		X	
<u>Ageratum conyzoides</u> L.	Ageratum, maile-honohono	X		X	X
<u>Bidens pilosa</u> var. <u>minor</u> (Bl.) Sherff		X		X	X
<u>Dubautia laxa</u> H. & A.	Ma'ena'e-pua-metemele	E		X	
<u>Eclipta alba</u> (L.) Hassk.	False daisy	X			X
<u>Emilia sonchifolia</u> (L.) DC.	Lilac pualele	X			X
<u>Erechtites valerianaeifolia</u> (Wolf) DC.	Hairy horseweed, ilioha	X		X	X
<u>Erigeron bonariensis</u> L.	Canada fleabane, horseweed	X		X	X
<u>E. canadensis</u> L.					
<u>Eupatorium riparium</u> Regel	Spreading mist flower, pamakani	X		X	
<u>Pluchea odorata</u> (L.) Cass.	Pluchea, shrubby fleabane	X		X	X
<u>Sonchus oleraceus</u> L.	Sow thistle, pua tele	X			X

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE			
					1	2	3a	3b 4
DICOTYLEDONAE								
AMARANTHACEAE								
<u>Charpentiera tomentosa</u> Sohm	Papala	E						X
ANACARDIACEAE								
<u>Mangifera indica</u> L.	Mango, manako	X				X	X	X
<u>Schinus terebinthifolius</u> Raddi	Christmas berry, wilelāiki	X			X		X	X
APOCYNACEAE								
<u>Alyxia olivaeformis</u> Gaud.	Maile	E				X	X	X
<u>Ochrosia compta</u> K. Schum.	Holei	E	E	D, R, En, C		X		
<u>Rauvolfia sandwicensis</u> A. DC.	Hao	E				X	X	
AQUIFOLIACEAE								
<u>Ilex anomala</u> H. & A.	Kawa'u	E				X	X	X
ARALIACEAE								
<u>Brassaia actinophylla</u> Endl.	Umbrella tree, octopus tree	X					X	X
<u>Cheirodendron trigynum</u> var. <u>Fosbergii</u> Sherff?								
<u>Reynoldsia sandwicensis</u> Gray	Olapa	E				X		
	'Ohe makai, 'ohe-o-kai	E						X
The genus <i>Tetraplasandra</i> is taxonomically poorly understood. Therefore, the following Hawaiian <i>Tetraplasandra</i> species are drawn from Sherff (1955). They have been collected from this area previously. The taxa are primarily found in study sites 1 and 2.								
<u>Tetraplasandra gymnocarpa</u> (Hbd.) Sherff	'Ohe	E		D				
<u>T. gymnocarpa</u> var. <u>pupukeensis</u> (Deg.) Sherff	'Ohe	E	E	EN				
<u>T. meliandra</u> var. <u>longipedunculata</u> Skottsb.		E		D, U				
<u>T. pupukeensis</u> Skottsb.	'Ohe	E	E	VL, EN, R, C				
<u>T. pupukeensis</u> var. <u>decipiens</u> Deg. & Sherff	E VL, U							
<u>T. pupukeensis</u> var. <u>megalopoda</u> Sherff	'Ohe	E						
 <u>T. pupukeensis</u> var. <u>megalopoda</u> f. <u>trigona</u> Deg. & Sherff								
	'Ohe	E						
<u>T. pupukeensis</u> var. <u>venosa</u> Deg. & Sherff	'Ohe	E		D, R, U, PoEM				
<u>Tetraplasandra</u> sp.	'Ohe	E				X		
<u>Tetraplasandra</u> sp.	'Ohe	E				X		
<u>Tetraplasandra</u> sp.	'Ohe	E				X		
<u>Tetraplasandra</u> sp.	'Ohe	E					X	
<u>Tetraplasandra</u> sp.	'Ohe	E						X
<u>Tetraplasandra</u> sp.	'Ohe	E				X		
BIGNONIACEAE								
<u>Spathodea campanulata</u> Beauv.	African tulip tree	X					X	X
CASUARINACEAE								
<u>Casuarina equisetifolia</u> Stickm.	Common ironwood, paina	X					X	X
<u>C. glauca</u> Sieb.	Longleaf ironwood	X					X	X
CELASTRACEAE								
<u>Perrottetia sandwicensis</u> Gray	Olomea	E					X	X
COMPOSITAE								
<u>Acanthospermum australe</u> (Loefl.) Ktze.	Spiny-bur, star-bur, kukae-hipa	X						X
<u>Adenostemma laevigata</u> (L.) Ktze.	Kamanamana	I						X
<u>Ageratum conyzoides</u> L.	Ageratum, maile-honohono	X				X	X	X
<u>Bidens pilosa</u> var. <u>minor</u> (Bl.) Sherff	False daisy	X					X	X
<u>Dubautia laxa</u> H. & A.	Ma'ens'e-pua-melemele	E				X		
<u>Eclipta alba</u> (L.) Hassk.		X						X
<u>Emilia sonchifolia</u> (L.) DC.	Lilac pualele	X						X
<u>Erechtites valerianaeifolia</u> (Wolf) DC.		X				X	X	X
<u>Erigeron bonariensis</u> L.	Hairy horseweed, ilioha	X				X		X
<u>E. canadensis</u> L.	Canada fleabane, horseweed	X						X
<u>Eupatorium riparium</u> Regel	Spreading mist flower, pamakani	X				X		
<u>Pluchea odorata</u> (L.) Cass.	Pluchea, shrubby fleabane	X					X	X
<u>Sonchus oleraceus</u> L.	Sow thistle, pua tele	X						X

Kahuku Training Area Plant Checklist (cont.)

SCIENTIFIC NAME	COMMON NAME	STATUS FR	FH	RELATIVE ABUNDANCE			
				1	2	3a	3b 4
COMPOSITAE continued							
<i>Synedrella</i> sp.		X					X
<i>Taraxacum officinale</i> (L.) Weber	Dandelion, lau-lele	X					X
<i>Vernonia cinerea</i> (L.) Less.	Ironweed	X					X
<i>Youngia japonica</i> (L.) DC.	Oriental hawksbeard	X			X		
CONVOLVULACEAE							
<i>Ipomoea alba</i> L.	Moon flower	X				X	X
<i>I. congesta</i> R. Br.	Koali-lawania	I				X	
<i>Operculina turpethum</i> (L.) S. Manso	Wood rose	X					X
EBENACEAE							
<i>Diospyros ferrea</i> subsp. <i>sandwicensis</i> (A.DC.) Fosb.	Lama	E			X	X	X
<i>D. hillebrandii</i> (Seem.) Fosb.		E			X	X	X
EPACRIDACEAE							
<i>Styphelia tameiameia</i> (Cham.) F. Muell.	Pukiawe	I			X	X	X
ERICACEAE							
<i>Vaccinium dentatum</i> Sm.	'Ohelo	E			X		
EUPHORBIACEAE							
<i>Aleurites moluccana</i> (L.) Willd.	Candlenut tree, kukui	P			X	X	X
<i>Antidesma platyphyllum</i> Mann	Hame, mehame	E			X	X	X
<i>Euphorbia glomerata</i> (Millsp.) L.C. Wheeler	X					X	
<i>E. hirta</i> L.	Garden spurge, koko-kahiki	X					X
<i>E. multifloris</i> var.?		E				X	
<i>E. prostrata</i> Ait.	Prostrate spurge	X					X
<i>Phyllanthus debilis</i> Klein ex Willd.	Phyllanthus weed	X					X
<i>P. sandwicensis</i> Muell.-Arq.	Pa-makani-mahu	E				X	X

[illegible]

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE				
					1	2	3a	3b	4
COMPOSITAE continued									
<u>Synedrella</u> sp.		X							X
<u>Taraxacum officinale</u> (L.) Weber	Dandelion, lau-tele	X							X
<u>Vernonia cinerea</u> (L.) Less.	Ironweed	X							X
<u>Youngia japonica</u> (L.) DC.	Oriental hawkbeard	X				X			
CONVOLVULACEAE									
<u>Ipomoea alba</u> L.	Moon flower	X					X	X	
<u>I. congesta</u> R. Br.	Koali-tawania	I						X	
<u>Oreocula turpethum</u> (L.) S. Manso	Wood rose	X							X
EBENACEAE									
<u>Diospyros ferrea</u> subsp. <u>sandwicensis</u> (A. DC.) Fosb.	Lama	E				X	X	X	X
<u>D. hillebrandii</u> (Seem.) Fosb.		E					X	X	X
EPACRIDACEAE									
<u>Styphelia tameiameia</u> (Cham.) F. Muell.	Pukiawe	I				X	X	X	X
ERICACEAE									
<u>Vaccinium dentatum</u> Sm.	'Ohelo	E				X			
EUPHORBIACEAE									
<u>Aleurites moluccana</u> (L.) Willd.	Candlenut tree, kukui	P					X		X
<u>Antidesma platyphyllum</u> Mann	Hame, mehame	E				X	X	X	X
<u>Euphorbia glomerifera</u> (Mills.) L.C. Wheeler	X								X
<u>E. hirta</u> L.	Garden spurge, koko-kahiki	X							X
<u>E. multiflora</u> var.?		E					X		
<u>E. prostrata</u> Ait.	Prostrate spurge	X							X
<u>Phyllanthus debilis</u> Klein ex Willd. ●	Phyllanthus weed	X							X
<u>P. sandwicensis</u> Muell.-Arq.	Pa-makani-mahu	E					X		X
FLACOURTIACEAE									
<u>Xylocarpus hawaiiense</u> Seem.	Haua	E					X	X	
GENTIANACEAE									
<u>Centaurium erythraea</u> Rafn.	Bitter herb, European centaury	X							X
GESNERIACEAE									
<u>Cyrtandra stupanthe</u> St. John & Storey	Ha'i wale	E							X
GOODENIACEAE									
<u>Scaevola gaudichaudiana</u> Cham.	Naupaka-kuahiwi	E					X	X	X
<u>S. glabra</u> H. & A.	Ohe naupaka	E				X			
<u>S. mollis</u> H. & A.	Naupaka	E						X	
LABIATAE									
<u>Phyllostegia grandiflora</u> (Gaud.) Benth.	Kapana	E				X			
LAURACEAE									
<u>Cassytha filiformis</u> L.	Kauna'oa-uka, pololo	I							X
<u>Persea americana</u> Mill	Avocado	X					X		
LEGUMINOSAE									
<u>Acacia confusa</u> Merr.	Formosan koa	X							X
<u>A. koa</u> Gray	Koa	E				X	X	X	X
<u>Albizia</u> sp.		X					X	X	
<u>Cassia leschenaultiana</u> DC.	Partridge pea, lauki	X					X	X	X
<u>Crotalaria mucronata</u> Desv.		X							X
<u>Crotalaria</u> sp.		X							X
<u>Desmanthus virgatus</u> (L.) Willd.	Virgate mimosa	X							X
<u>Desmodium triflorum</u> (L.) DC.	Three-flowered beggarweed	X							X
<u>D. uncinatum</u> (Jacq.) DC.	Spanish clover, pua pili-pili	X						X	X
<u>Indigofera suffruticosa</u> Mill.	Indigo, 'iniko	X					X		X
<u>Leucaena leucocephala</u> (Lam.) de Wit	Koa-haole	X					X		X
<u>Mimosa pudica</u> var. <u>uni-juga</u> (Duchass. & Walp.) Griseb.	Sensitive plant, pua-hilahila	X						X	X
<u>Phaseolus lathyroides</u> L.	Cow pea	X				X			

Kahuku Training Area Plant Checklist (cont.)

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE			
					1	2	3a	3b 4
LOBELIACEAE								
<u>Clermontia takeana</u> Walp.	Ohia-wai, haha	E			X	X		
<u>C. persicifolia</u> Gaud.		E			X			
<u>Cyanea angustifolia</u> (Cham.) Hbd.		E			X	X	X	X
<u>Trematolobelia macrostachys</u> (H. & A.) Zahlbr.	Koli'i	E			X			
LOGANIACEAE								
<u>Buddleia asiatica</u> Lour.	Dogtail, Asiatic butterfly bush	X					X	
LORANTHACEAE								
<u>Korthalsella complanata</u> (v. Tiegh.) Engler	Hulumoa, kaumahana	E			X	X	X	
<u>K. latissima</u> (v. Tiegh.) Danser	Hulumoa	E				X		
LYTHRACEAE								
<u>Cuphea carthagenensis</u> (Jacq.) Macbride	Tarweed, Colombian cuphea	X			X	X	X	
<u>Lagerstroemia speciosa</u> (L.) Pers.	Giant crape myrtle	X				X		
MALVACEAE								
<u>Hibiscus tiliaceus</u> L.	Hau	I			X	X	X	
<u>Sida rhombifolia</u> L.	Cuba jute	X						X
<u>S. spinosa</u> L.	Prickly sida	X						X
MELASTOMACEAE								
<u>Arthrosterma</u> (?) sp.		X			X	X	X	
<u>Clidemia hirta</u> (L.) D. Don	Koster's curse	X			X	X	X	X
MENISPERMACEAE								
<u>Cocculus ferrandianus</u> Gaud.	Huehue	E					X	X
MORACEAE								
<u>Artocarpus altillis</u> (Parkins. ex Z) Fosb.	Breadfruit, 'ulu	P						X
<u>Cecropia peltata</u> Sandmark	Trumpet tree, guarumo	X					X	

<u>Ficus macrophylla</u> Desf.	Moreton Bay fig	X	X
<u>F. lacer</u> Buch.-Ham.		X	X
<u>F. rubiginosa</u> Desf.	Port Jackson fig	X	X
<u>Ficus</u> sp.		X	X
<u>Ficus</u> sp.		X	X
<u>Ficus</u> sp.		X	X
MYRSINACEAE			
<u>Ardisia humilis</u> Vahl	Shoebutton ardisia	X	X X
<u>Myrsine lessertiana</u> A. DC.	Kolea-lau-nui	E	X
<u>M. sandwicensis</u> A. DC.	Kolea-lau-li'i	E	
MYRTACEAE			
<u>Eucalyptus citriodora</u> Hook.	Lemon-scented gum	X	X
<u>E. deglupta</u> Bl.	Bagras eucalyptus	X	X X
<u>E. robusta</u> Sm.	Swamp mahogany	X	X
<u>Eugenia cuminii</u> (L.) Druce	Java plum, palama	X	X X
<u>E. jambos</u> L.	Rose apple, 'ohi'a-loke	X	X
<u>E. malaccensis</u> L.	Mountain apple, 'ohi'a-ai	P	X X
<u>E. sandwicensis</u> Gray	Ha, 'ohi'a-ha	E	X
<u>Leptospermum scoparium</u> J. R. & G. Forst.	Manuka, tea tree	X	X
<u>L. scoparium</u> var. <u>incanum</u> Cockayne		X	X
<u>Melaleuca leucadendra</u> (Stickm.) L.	Paperbark tree	X	X X
<u>Metrosideros collina</u> ssp. <u>polymorpha</u> (Gaud.) Rock		X	X
<u>M. rugosa</u> Gray	'Ohi'a-lehua, lehua	E	X X
<u>M. tremuloides</u> (Heller) Knuth	Lehua-papa	E	X
<u>Pimenta dioica</u> (L.) Merr.	Lehua-'ahihi	E	X
<u>Psidium cattleianum</u> Sabine	Allspice		X
<u>f. cattleianum</u>	Purple strawberry guava, waiawi 'ula 'ula	X	X X
<u>P. cattleianum</u> f. <u>lucidum</u> Deg.	Yellow strawberry guava		X X
	waiawi	X	X
<u>P. guajava</u> L.	Guava, kuawa	X	X X
<u>Syncarpia glomulifera</u> (Sm.) Neidz.	Turpentine tree	X	X X

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE				
					1	2	3a	3b 4	
LOBELIACEAE									
<u>Clermontia kakeana</u> Walp.	Oha-wai, haha	E				X	X		
<u>C. persicifolia</u> Gaud.		E				X			
<u>Cyanea angustifolia</u> (Cham.) Hbd.		E					X	X X	
<u>Trematolobelia macrostachys</u> (H. & A.) Zahlbr.	Koli'i	E				X			
LOGANIACEAE									
<u>Buddleia asiatica</u> Lour.	Dogtail, Asiatic butterfly bush	X						X	
LORANTHACEAE									
<u>Korthalsella complanata</u> (v. Tiegh.) Engler	Hulmoo, kaumahana	E				X	X	X	
<u>K. latissima</u> (v. Tiegh.) Danser	Hulmoo	E				X			
LYTHRACEAE									
<u>Cuphea carthagenensis</u> (Jacq.) Macbride	Tarweed, Colombian cuphea	X				X		X X	
<u>Lagerstroemia speciosa</u> (L.) Pers.	Giant crape myrtle	X					X		
MALVACEAE									
<u>Hibiscus tiliaceus</u> L.	Hau	I					X	X X	
<u>Sida rhombifolia</u> L.	Cuba jute	X						X	
<u>S. spinosa</u> L.	Prickly sida	X						X	
MELASTOMACEAE									
<u>Arthrostemma</u> (?) sp.		X				X	X	X X	
<u>Clidemia hirta</u> (L.) D. Don	Koster's curse	X				X	X	X X X	
MENISPERMACEAE									
<u>Cocculus ferrandianus</u> Gaud.	Huehue	E						X X	
MORACEAE									
<u>Artocarpus altitilis</u> (Parkins. ex Z) Fosb.	Breadfruit, 'ulu	P						X	
<u>Cecropia peltata</u> Sandmark	Trumpet tree, guarumo	X				X			
FICACEAE									
<u>Ficus macrophylla</u> Desf.	Moreton Bay fig	X						X	
<u>F. lacor</u> Buch.-Ham.		X						X	
<u>F. rubiginosa</u> Desf.	Port Jackson fig	X				X			
<u>Ficus</u> sp.		X						X	
<u>Ficus</u> sp.		X				X			
<u>Ficus</u> sp.		X						X	
MYRSINACEAE									
<u>Ardisia humilis</u> Vahl	Shoebutton ardisia	X				X	X	X	
<u>Myrsine lessertiana</u> A. DC.	Kolea-lau-nui	E				X			
<u>M. sandwicensis</u> A. DC.	Kolea-lau-li'i	E				X			
MYRTACEAE									
<u>Eucalyptus citriodora</u> Hook.	Lemon-scented gum	X					X		
<u>E. dealupta</u> Bl.	Bagras eucalyptus	X					X	X X	
<u>E. robusta</u> Sm.	Swamp mahogany	X					X	X	
<u>Eugenia cuminii</u> (L.) Druce	Java plum, palama	X					X	X	
<u>E. jambos</u> L.	Rose apple, 'ohi'a-loke	X					X	X	
<u>E. malaccensis</u> L.	Mountain apple, 'ohi'a-ai	P						X	
<u>E. sandwicensis</u> Gray	Ha, 'ohi'a-ha	E				X	X	X X	
<u>Leptospermum scoparium</u> J. R. & G. Forst.	Manuka, tea tree	X				X			
<u>L. scoparium</u> var. <u>incanum</u> Cockayne		X					X		
<u>Melaleuca leucadendra</u> (Stickm.) L.	Paperbark tree	X					X	X X X	
<u>Metrosideros collina</u> ssp. <u>polymorpha</u> (Gaud.) Rock	'Ohi'a-lehua, lehua	E				X	X	X X X	
<u>M. rugosa</u> Gray	Lehua-papa	E				X			
<u>M. tremuloides</u> (Heller) Knuth	Lehua-'ahihi	E					X		
<u>Pimenta dioica</u> (L.) Merr.	Allspice							X	
<u>Psidium cattleianum</u> Sabine	Purple strawberry guava,								
<u>f. cattleianum</u>	waiwai 'ula 'ula	X				X	X	X X X	
<u>P. cattleianum</u> f. <u>lucidum</u> Deg.	Yellow strawberry guava								
	waiwai	X				X		X X	
<u>P. guajava</u> L.	Guava, kuawa	X				X	X	X X	
<u>Syncarpia glomulifera</u> (Sm.) Neidz.	Turpentine tree	X					X	X	

Kahuku Training Area Plant Checklist (cont.)

SCIENTIFIC NAME	COMMON NAME	STATUS FR	FH	RELATIVE ABUNDANCE			
				1	2	3a	3b 4
NYCTAGINACEAE							
<i>Bougainvillea</i> sp.	Bougainvillea	X					X
<i>Mirabilis jalapa</i> L.	Common four o'clock, marvel of Peru, nani-ahiahi	X					X
<i>Pisonia</i> sp.		E					X
OLEACEAE							
<i>Noronhia emarginata</i> (Lam.) Stadlm.	Madagascar olive	X			X		
<i>Olea africana</i> Mill.		X					X
<i>Osmanthus sandwicensis</i> (Gray) Knobl.	Olopua, pua	E			X	X	X
ONAGRACEAE							
<i>Ludwigia octovalvis</i> (Jacq.) Raven	Primrose willow	X			X		X
OXALIDACEAE							
<i>Oxalis corniculata</i> L.	Yellow wood sorrel, 'ihi	X					X
PASSIFLORACEAE							
<i>Passiflora edulis</i> Sims f. <i>edulis</i>	Purple granadilla, liliko'i	X					X
<i>P. edulis</i> f. <i>flavicarpa</i> Deg.	Yellow liliko'i, liliko'i melele	X					X
<i>P. foetida</i> L.	Scarlet-fruited passion flower	X					X
<i>P. laurifolia</i> L.	Yellow granadilla, lemi-wai	X					X
<i>P. ligularis</i> Juss.	Sweet granadilla, lemi-wai	X					X
<i>P. suberosa</i> L.	Huehue-haole	X					X
PIPERACEAE							
<i>Peperomia tetraphylla</i> (Forst. f.) H. & A.	'Ala 'ala-wai-nui kane	I					X
<i>Peperomia</i> sp.	'Ala 'ala-wai-nui kane	E?I?					X

PITTOSPORACEAE

- Pittosporum cladanthum var. reticulatum (Skottb.) Sherff
P. sulcatum Sherff
Pittosporum sp.

Ho'awa E X X X
 Ho'awa E X
 Ho'awa E X

PLANTAGINACEAE

- Plantago lanceolata L.

Narrow-leaved plantain X X X

PROTEACEAE

- Grevillea robusta A. Cunn.

Silver oak, silk oak, 'oka kilika X X X

ROSACEAE

- Osteomeles anthyllidifolia Lindl.
Rubus rosaefolius Sm.

Uulei, 'ulei E X X X
 Thimbleberry, 'olala X X X X

RUBIACEAE

- Bobea elatio Gaud.
B. hookeri Hbd.
Borreria laevis (Lam.) Griseb.
Canthium odoratum (Forst. f.) Seem.
Gardenia mannii St. John & Kukend.
Gouldia terminalis (H. & A.) Hbd.
Morinda citrifolia L.
Psychotria hexandra ssp. oahuensis Deg. & Fosb.
P. kaduana (C. & S.) Fosb.
Richardia brasilensis Gomez

'Ahakea E X X
 'Ahakea E X
 Buttonweed X X
 Alahe'e, walahe'e I X X X
 Nanu E X
 Manono E X X X
 Noni P X X X
 Kopiko E X X
 Kopiko-kea E X
 Richardsonia X X

RUTACEAE

- Pelea clusiaefolia Gray
P. oahuensis Levl.
P. peduncularis var. quadrata Stone
Zanthoxylum dipetalum Mann

Kukae-moa E X
 Alani E X
 Alani E X
 Kawa'u E X

SANTALACEAE

- Santalum freycinetianum Gaud.

Freycinet sandalwood, 'ili-ahi E X X X

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE				
					1	2	3a	3b	4
NYCTAGINACEAE									
<u>Bougainvillea</u> sp.	Bougainvillea	X							X
<u>Mirabilis jalapa</u> L.	Common four o'clock, marvel of Peru, nani-ahiahi	X							X
<u>Pisonia</u> sp.		E						X	
OLEACEAE									
<u>Moronia emarginata</u> (Lam.) Stadn.	Madagascar olive	X				X			
<u>Olea africana</u> Mill.		X							X
<u>Osmanthus sandwicensis</u> (Gray) Knobl.	Dlopus, pus	E				X	X	X	
ONAGRACEAE									
<u>Ludwigia octovalvis</u> (Jacq.) Raven	Primrose willow	X				x	X	X	
OXALIDACEAE									
<u>Oxalis corniculata</u> L.	Yellow wood sorrel, 'ihī	X						X	X
PASSIFLORACEAE									
<u>Passiflora edulis</u> Sims f. <u>edulis</u>	Purple granadilla, liliko'i	X							X
<u>P. edulis</u> f. <u>flavicarpa</u> Deg.	Yellow liliko'i, liliko'i melele	X							X
<u>P. foetida</u> L.	Scarlet-fruited passion flower	X						X	X
<u>P. laurifolia</u> L.	Yellow granadilla, lemi-wai	X						X	X
<u>P. ligularis</u> Juss.	Sweet granadilla, lemi-wai	X				X			
<u>P. suberosa</u> L.	Huehue-haole	X						X	X
PIPERACEAE									
<u>Peperomia tetraphylla</u> (Forst. f.) H. & A.	'Ala 'ala-wai-nui kane	I						X	
<u>Peperomia</u> sp.	'Ala 'ala-wai-nui kane	E717						X	
PITTOSPORACEAE									
<u>Pittosporum cladanthum</u> var. <u>reticulatum</u> (Skottb.) Sherff	Ho'awa	E					X	X	X
<u>P. sulcatum</u> Sherff	Ho'awa	E					X		
<u>Pittosporum</u> sp.	Ho'awa	E					X		
PLANTAGINACEAE									
<u>Plantago lanceolata</u> L.	Narrow-leaved plantain	X						X	X
PROTEACEAE									
<u>Grevillea robusta</u> A. Cunn.	Silver oak, silk oak, 'oka kilika	X						X	X
ROSACEAE									
<u>Osteomeles anthyllidifolia</u> Lindl.	Ulei, 'ulei	E						X	X
<u>Rubus rosaefolius</u> Sm.	Thimbleberry, 'ola'a	X						X	X
RUBIACEAE									
<u>Bobea elatior</u> Gaud.	'Ahakea	E					X	X	
<u>B. hookeri</u> Hbd.	'Ahakea	E					X		
<u>Borreria laevis</u> (Lam.) Griseb.	Buttonweed	X							X
<u>Canthium odoratum</u> (Forst. f.) Seem.	Alahe'e, walahe'e	I						X	X
<u>Gardenia mannii</u> St. John & Kukend.	Manu	E					X		
<u>Gouldia terminalis</u> (H. & A.) Hbd.	Manono	E					X	X	X
<u>Morinda citrifolia</u> L.	Noni	P						X	X
<u>Psychotria hexandra</u> ssp. <u>oahuensis</u> Deg. & Fosb.	Kopiko	E					X	X	
<u>P. kaduana</u> (C. & S.) Fosb.	Kopiko-kea	E					X		
<u>Richardia brasiliensis</u> Gomez	Richardsonia	X							X
RUTACEAE									
<u>Pelea clusiaefolia</u> Gray	Kukae-moa	E					X		
<u>P. oahuensis</u> Levl.	Alani	E					X		
<u>P. peduncularis</u> var. <u>quadrata</u> Stone	Alani	E					X	X	
<u>Zanthoxylum dipetalum</u> Mann	Kawa'u	E					X		
SANTALACEAE									
<u>Santalum freycinetianum</u> Gaud.	Freycinet sandalwood, 'ili-ahi	E						X	X

SCIENTIFIC NAME	COMMON NAME	STATUS	FR	FH	RELATIVE ABUNDANCE			
					1	2	3a	3b 4
SAPINDACEAE								
<u>Dodonaea sandwicensis</u> Sherff	'A'ali'i	E					X	
SAPOTACEAE								
<u>Planchonella sandwicensis</u> (Gray) Pieere	Alulu, kaulu	E			X	X	X	
SAXIFRAGACEAE								
<u>Broussaia arguta</u> Gaud.	Kanawao, kanawau	E			X			
SOLANACEAE								
<u>Physalis peruviana</u> L.	Cape gooseberry, pohu	X					X	
STERCULIACEAE								
<u>Waltheria americana</u> L.	Hi'a-loa, 'Uha-loa	I					X	
TILIACEAE								
<u>Elaeocarpus bifidus</u> H. & A.	Kalia	E			X	X	X	
<u>E. grandis</u> F. Muell.	Blue marble tree	X					X	
THYMELAEACEAE								
The genus Wikstroemia has many ill-defined Hawaiian species, some of them poorly understood. Many of our specimens lacked flowers for proper identification. The first five taxa listed are drawn from Skottsberg (1972) and have been collected from this area.								
<u>Wikstroemia degeneri</u> Skottsb.	'Akia	E						
<u>W. oahuensis</u> (Gray) Rock	'Akia	E						
<u>W. recurva</u> (Hbd.) Skottsb.	'Akia	E						
<u>W. sellingsii</u> Skottsb.	'Akia	E						
<u>W. vacciniifolia</u> Skottsb.	'Akia	E						
<u>W. uva-ursi</u> Gray	'Akia	E						
<u>Wikstroemia</u> sp.	'Akia	E				X	X	
<u>Wikstroemia</u> sp.	'Akia	E					X	

<u>Wikstroemia</u> sp.					
<u>Wikstroemia</u> sp.					
	'Akia	E		X	X
	'Akia	E			X
UMBELLIFERAE					
<u>Centella asiatica</u> (L.) Urban					
	Asiatic pennywort, pohe kula	X	X	X	X
URTICACEAE					
<u>Pipturus albidus</u> (H. & A.) Gray					
	Mamaki, mamake	E			X
VERBENACEAE					
<u>Lantana camara</u> L.					
	Lantana, lakana	X		X	X
<u>Stachytarpheta jamaicensis</u> (L.) Vahl					
	Jamaica vervain, oi, owi	X		X	X
<u>Verbena litoralis</u> HBK.					
	Weed verbena	X			X

SAPINDACEAE

Y

SAPOTACEAE

X X X X

SAXIFRAGACEAE

Y

SOLANACEAE

x

STERCULIACEAE

Y

TILIACEAE

✕ ✕ ✕

22

THYMELAEACEAE

E

E

E

E

2
3E
F

Y

2

X X

Y

UMBELLIFERAE

X X X X X

URTICACEAE

X

VERBENACEAE

✕ ✕ ✕ ✕ ✕

✕

✕

HAWAIIAN BOTANICAL SOCIETY
Minutes of the June, 1986 meeting

President Lewis called the meeting to order at 7:30 p.m. The minutes of the May meeting were read and approved. The Treasurer's report was presented and indicated a balance of \$2,375.71 on June 1, 1986.

It was announced that the membership committee was being assumed by Dr. Don Gowing. He reported that, as of June 1, there were 159 members of the Society.

Under new business the president announced that the June meeting would be the last time this year that she would be able to preside over the Society meetings. She was preparing to conduct her research for the Ph.D. on some aspects of the marine algae on Hunan Island, China.

The speaker for the month was Faith Roelofs, executive director of the Hawaii Nature Center in Makiki. Faith showed a video on the science of plants entitled "It's Science, Isn't It?" which is being produced by the State Department of Education for sixth graders.

Respectfully submitted,
Christa Russell, Secretary.

Minutes of the October, 1986 Meeting

The Vice-president, Mr. Rylan N.S. Yee called meeting to order at 7:30 p.m. The minutes were approved as read.

No business was conducted at the meeting.

The Vice-president introduced the speaker of the month, Dr. K. Nagata, Lyon Arboretum, who spoke on the "Ethnobotany of Nepal. The plant of the month speaker was Dr. Warren Wagner, Bishop Museum who spoke on "Hybrids in Cyrtandra.

Respectfully submitted,
Christa Russell, Secretary.

Minutes of the November, 1986 meeting

Vice-president Yee called the meeting to order at 7:00 p.m. The minutes of the October meeting were read and corrected. The Treasurer's report was presented. The balance as of November 1, 1986 was \$2860.34.

Don Gowing, membership committee, reported that Marie H. Sachet passed late last summer. Don also announced that back

issues of the Society's publications are available from him. Peter O'Connor announced that C. Robert Long who was a botany graduate student at UH in the 60's, and then librarian at N.Y. Botanical Garden, died in August.

Under old business, the proposed resolution to offer a reward for information leading to the capture and arrest of the person(s) starting the Pu'uwa'awa'a fire stimulated a lively discussion but was narrowly defeated.

Under new business, Alan Holt of the Hawaii Nature Conservancy (THNC), asked the membership to support a resolution for a joint management between THNC and the Society to provide volunteer labor and scientific expertise for the protection of Marsilea villosa at Koko Head. THNC would write the management plan which, if approved by the city, would be implemented by members of the Society. The resolution was approved by the members present.

Alan also announced that a part-time position was open at THNC for a stewardship intern. The Vice-president announced that Dr. St. John needs a volunteer work processor typist for his Flora of Idaho manuscript.

The speaker of the month was Dr. Mark Merlin of the UH General Science department who talked on "Plants of the Southern Cook Islands." The meeting was adjourned at 8:45 p.m. at which time the membership retired to enjoy refreshments.

Respectfully submitted,
Christa Russell, Secretary.

HAVE YOU BEEN HIKING IN THE WAIANAES IN THE LAST FEW YEARS?

Have you seen or made collections of rare plants in the Waianae Mountains? If so, The Nature Conservancy's Hawaii Heritage Program would like to talk to you. They are updating collection information on rare plants in the Waianaes for a contract on which they are currently working. They would particularly like to receive information on observations or collections made in the last five years.

Please call Christa Russell or Audrey Newman at 537-4508 Monday through Saturday.

January Meeting

Speaker: Dr. Charles H. Lamoureux.
"Indonesian Adventures with Plants."

HAWAIIAN BOTANICAL SOCIETY
C/O DEPARTMENT OF BOTANY
UNIVERSITY OF HAWAII AT MANOA
3190 MAILE WAY
HONOLULU HI 96822 U.S.A.

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by Donald P. Gowing
February 1987



Published by the Hawaiian Botanical Society, which was founded in 1924 to "advance the science of botany in all its applications, encourage research in botany in all its phases, promote the welfare of its members and develop the spirit of good fellowship and cooperation among them." Any person interested in the plant life of the Hawaiian Islands is eligible for membership. Information may be obtained from the Society, c/o Department of Botany, 3190 Maile Way, University of Hawaii, Honolulu, Hawaii 96822.

NOTE ON THE USE OF THE INDEX

Both parts of the index include references within the text of the articles as well as keywords from titles.

In Part 1, scientific names are given (in italics) only when the taxon is the principal subject, but the index to plant genera in Part 2 includes all references where the scientific name is given.

Alternative generic names still in occasional use are given in [Brackets], but misspellings are given in brackets and ["Quotes"], thus.

Contributors' names are in caps, as "ABBOTT,I.A.", but other references to individuals (as the subject or as speaker, officer, etc.) are shown as "Abbott,I.A."

Volume numbers are underlined; multiple entries in one volume are numbered sequentially without repeating the volume number. The symbol "ff" indicates contributions by the same author, or on the same topic, on successive pages, or indicates more than two references to the same taxon in the same article.

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